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THE

RURAL CYCLOPEDIA,

OR A

GENERAL DICTIONARY OF AGRICULTURE,

AND OF THE

ARTS, SCIENCES, INSTRUMENTS, AND PRACTICE,

NECESSARY TO THE

FARMER, STOCKFARMER, GARDENER,

FORESTER, LANDSTEWARD,

FARRIER, &c.

EDITED BY THE

REV. JOHN M. WILSON.

VOLUME II.

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THE RURAL CYCLOPEDIA.

DAB-CHICK. A newly-hatched chick.

DACRYDIUM. A small genus of half-tender, ornamental, evergreen trees, of the cyprus division of the coniferous order. The name is formed from a Greek word signifying "a tear," and refers to the exudation of a gummy secretion. Only two species have been brought to Britain, the cypress-like, *D. cupressinum*, a native of New Zealand, and the lofty, *D. elatum*, a native of some parts of the Indian archipelago. Both attain a height of about 20 feet.

DACTYLIS,—popularly *Cock's-Foot Grass.* A genus of grasses of the fescue division. The rough or glomerated species, or orchard-grass of America, *D. glomerata* (*Plate XXIX.*), is a well-known and valuable indigenous grass. Its root is fibrous and perennial; its culm is rough, and about 2 or 2½ feet high; its leaves are rough, keeled, broad, and slightly glaucous-green; its panicle is one-sided; and its spikelets are crowded and three or four flowered. Its habit of growth is tufty and somewhat unsightly. It abounds on most pastures and all waste places which are not closely cropped by sheep or cattle; and when cultivated, it yields a large produce, rapidly reproduces its herbage after being cut, and, if kept constantly low by the scythe or by grazing, is more valuable in pasture than rye-grass. In the Woburn experiments, it yielded per acre, at the time of flowering, 27,905 lbs. of green produce, 11,859 lbs. of hay, and 1,089 lbs. of nutritive matter; but it was found to lose bulk and value when allowed to grow to seed. When not eaten down in spring, it becomes hard and coarse; and when constantly depastured by sheep or cattle, it dies out in the course of about five or six years.

The tussac grass species, *Dactylis cæspitosa*, was introduced to Britain in 1844, and promises to be of great value in some departments of British husbandry; and it is figured in *Plate XXVII.*, and will be fully noticed in the article Tussac Grass.—Nine or ten other species have been introduced, and about as many more described; but all are worthless to the farmer, and attractive only to the botanist.

DAFFODIL,—botanically *Narcissus Pseudo-Narcissus.* An indigenous, bulbous-rooted, ornamental, flowering plant, of the amaryllis order. It grows naturally on the borders of woods, fields, and pastures, in many parts of Britain; and, if not in its natural state, at least in its cultivated varieties, is one of the most showy of our wild plants. It is very generally, but most improperly, called by the peasantry the yellow lily. Its bulb is large and orbicular; its leaves are 5 or 6 in number, and about a foot long and an inch broad; its stem is about 18 inches high, and has two sharp longitudinal angles; and its flower is monopetalous, but is deeply cut into six expanded segments, and has in its centre a cup or bell-shaped nectary. Cultivated varieties of it are exceedingly common in cottage and villa gardens, and make a very conspicuous figure in the months of March and April; all have flowers of some shade of yellow, principally a pale sulphur colour; and some are so exceedingly double as to exhibit a dense hemispherical mass of petals. Yet a Spanish species called Telamon's, *Narcissus Telamonius*, is the true origin of some of the finest garden daffodils. See the article Narcissus.

DAHLIA,—botanically *Georgina.* A genus of tuberous-rooted, magnificently-flowering, Mexican plants, of the sunflower division of the composite order. Its receptacle is chaffy, and its perianth consists of two calyxes,—the outer one many-leaved, and the inner one single-leaved. It is so exceedingly prolific of varieties, and has already sported itself into so many thousands of them, as almost to defy botanical classification; yet it comprises two very distinct original species, the one with fertile rays and the other with barren rays, after the manner of the two orders Superflua and Frustranea of the Linnæan class Syngenesia.

The fertile-rayed species, *Georgina pinnata* or

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Dahlia superflua, was introduced from Mexico to Spain and Britain in 1789; and, becoming lost from ignorance of its culture, was reintroduced to Britain in 1804. Its stem is free from hoariness, and usually from 3 to 6 feet high; its leaves are winged; its leaflets are ovate-acuminate, serrated, and shining, and have a smooth under-surface; and its outer calyx is reflexed.—The barren-rayed species, *Georgina frustranea* or *Dahlia frustranea*, was introduced from Mexico in 1802. Its stem is hoary; its leaves have a naked rachis and a roughish under-surface; and its outer calyx is spreading.—These characters are necessarily very general; and the characters of the innumerable varieties, particularly floral characters, are exceedingly diversified, and, in many instances, fluctuating or fugitive. Several classifications of the fine-flowering varieties have at different times been attempted, and come more or less into vogue; an early one of these distributed them into globe-flowered, anemone-flowered, and China-aster-flowered, and a somewhat later one distributed them into globe-flowered, anemone-flowered, and camellia-flowered, and made a subdivision of the last into single-coloured and several-coloured; but all such classifications, besides being botanically incorrect, have reference only to the form and colour of the flowers, and are exceedingly liable both to mislead the judgment and to vitiate the taste. The astonishing and ever active prolificity with which all seeding dahlias produce new varieties renders minute classification undesirable, and has powerfully stimulated a coarse and ridiculous passion for obtaining all possible sorts of outre or novel-looking flowers. The dahlia rushed into popularity almost with the speed of lightning; it enraptured all sorts of florists, in a great degree to the neglect of former favourites; it seized on the minds of myriads, and worked in them, almost in the manner of a mania; and it evoked a larger amount of both bad and good taste than probably any other ten popular favourites; but, though confessedly a most gorgeous plant, and though much too diversified and far too magnificent ever to fall back into obscurity, it has become so universally diffused and is capable of such cheap and facile multiplication, as to have fairly receded from fellowship with the aristocratic beauties of the flower-garden, and to be already of little more consideration than the common but superb hollyhock, and far on the way to challenge more attention to the possible value of its tubers than to the brilliance of its flowers. Its tubers were, a considerable time ago, tried in Paris as an esculent, and have, for probably fifteen years, been occasionally sold in the city markets of Britain under the assumed name of Jerusalem artichokes; they are capable of cultivation, abundant produce, and winter-storage by pitting, almost exactly in the manner of potatoes; and, though hitherto disliked for their flavour by both man and beast, they are rich in nutritive matter, and may possibly, with a slight aid from chemistry, be rendered well worthy of field-culture and farmyard consumption.

The dahlia, cultivated as a flowering-plant, will grow and bloom in almost any kind of soil; but is most vigorous and prolific in a rich loam, and acquires dwarfishness and early maturity from a very light, sandy, garden-mould. It may be grown either as an annual, from seeds, with the view of having numerous varieties of single and semidouble flowers; or as a perennial, from tubers, or from cuttings, with the view of obtaining fine blooms of some of the best existing varieties of double-flowering plants. Seeds may, in the early part of March, be sown in pots or boxes, to be placed in a hothouse or hotbed frame, and otherwise treated in the same manner as the seeds of tender annuals. The seedlings may be planted at distances of only a foot from plant to plant; and any one of them may possibly produce both single and double or semidouble flowers, but generally will produce the worst flowers first. Cultivation from both tubers and cuttings is now so universally known as not to require notice.

The criteria of a good or at least of a favourite double dahlia flower, are dependent on taste, and have greatly fluctuated with the sporting of the plant and the caprice of fashion. Yet one important rule seems to be generally admitted, that the size of a flower is only of half the importance of the colour, and of third the importance of the form. One frequent fault of even the best class of double flowers is the showing of the backs of the petals; and another is a sinking or packedness of the centre or "eye." The properties of all the good varieties are far from being constant, and depend in a considerable degree on the circumstances of culture. Dahlia plants ought not to be exposed to north and east winds; they ought not to receive any check to their growth; they ought never to receive a watering without having it over the whole of their foliage; and they ought, in dry hot weather, to be well syringed through a fine rose. We might give a list of the best varieties at present in the public nurseries; but we should lose our labour, for many of them will be out of fashion before we can get through the press.

DAHOON,—botanically *Ilex Dahoon*. An evergreen, ornamental shrub, of the holly genus. It is a native of various parts of North America, particularly of Carolina, and was introduced thence to Britain about 120 years ago. Its stem is erect, and covered with a brown bark, and grows tree-high in its native country, but attains a height of only 6 or 7 feet in Britain; its branches are numerous, and, while young, have a green and very smooth bark; its leaves are alternate, ovate-lanceolate, thickish, beautifully green, very fine in texture, and serratured in a much sharper and more minute manner than those of the common holly; and its flowers are small and white, and are produced in short thick clusters from the sides of the branches, and appear in May and June, but are not succeeded in Britain by any fruit. This beautiful shrub is usually propagated by grafting on common hollies, but may be raised from imported seed. The cassine is sometimes called a dahoon. See the article CASSINE.

DAIRY. An establishment for managing milk and cream, and for manufacturing butter and cheese. Some dairies are chiefly or wholly engaged in supplying the inhabitants of large towns with milk and cream; some are strictly private establishments for supplying the table of a great mansion with the freshest and best milk, butter, and cheese; some, for any or all of the departments of dairy produce, constitute an element or integral part of the affairs of a system of mixed husbandry; and some either chiefly for cheese, or chiefly for butter, or mixedly for various dairy produce, constitute the main drift of all such grass farms as are depastured with milk cows. We shall endeavour so to shape our remarks as to include the whole of these; yet we must necessarily make chief reference to the dairies either of farms entirely devoted to them or of extensive farms under a system of mixed husbandry.

A dairy establishment for supplying large towns with milk has, in most instances, no wider scope than the maintaining of a well-appointed cow-house, the stall-feeding of cows, and the regular, cleanly, and economical drawing and distributing of milk. It may have attached grounds for the raising of green crops for the cows, but is seldom connected with pasture-lands, or, in any ordinary sense of the word, with a farm. A private dairy establishment is provided with means and accompaniments, far less in the manner of economy than on principles of luxury; and therefore has a style far less in keeping with the industrious homeliness of a farm, than in keeping with the opulence and splendour of a mansion and pleasure-grounds. A true dairy farm is as strictly rural as either a stock farm or a farm of mixed husbandry; and, at the same time, is conducted wholly on principles of economy and profit. Any tillage practised on it is subservient to the feeding of its cows; and any other of its departments of industry are merely incidental to that of the dairy. No full-grown stock are fed on it in winter; and only a few heifer calves are reared at any time in order to supply the places of such cows as die or become unprofitable. Bull calves are sometimes fed for veal; pigs are often fattened on the refuse of milk; and young horses are, in some instances, reared on whey, spare milk, and part of the pastures. The occupant of a dairy farm requires to possess an intimate knowledge of the constitution, varieties, and management of cows, and of all the details of making and selling butter and cheese; but he does not need more acquaintance with the operations of mixed husbandry than will guide him in raising green crops and making hay. A dairy incurs far less risk from vicissitudes of weather and from variations in the price of produce than a mixed or arable farm; and therefore it lets at a higher rent, yields less profit to the tenant, and is less liable to the disasters of bankruptcy. It requires minute and constant attention to all the details and circumstances on which the obtaining of profit depends; and will hardly in any case make sufficient returns for even the moderate maintenance of a family, unless steadily and daily managed by the farmer himself and his wife. Its chief practical difficulty is winter-feeding; and this, in most instances, is mitigated, though considerably to the loss of the farmer and the detriment of his stock, by managing to have the cows dry at the period of greatest scarcity, and then supporting them on inferior food. The grand aim, whenever the circumstances and conditions of the farm will possibly admit of it, ought to be to have as much old pasture-land as will feed the cows throughout the summer portion of the year, and as much arable land under a rotation of green crops and cut grasses as will afford them abundance of food during winter; and this, on very large farms, may be materially aided, by breaking up the oldest or decaying portion of the pastures in order to subject them to a manured arable rotation, and by laying down to grass a corresponding portion of the land which has been longest in requisition for the raising of green crops and hay. See the article GRASS LANDS. The most extensive dairy districts of England are in Cheshire, Devonshire, and Gloucestershire.

The proper construction of the cow-house, and the right management of the cows, have been considered in the article Cow. The cow-house ought to be sufficiently near the dairy-house for the purposes of convenience, but not so near as to communicate any of the malodour and contamination of the gases and exhalations ascending from its dung, its urine, and its cattle. No stagnant waters, nor diffusions of liquid manure, nor heaps of compost, nor masses of fermenting herbage, nor rank growths of docks or nettles, nor any object whatever which might diffuse ammoniacal or carbonaceous matters through the air, or dilute the perfect purity of the local atmosphere, ought to be in the vicinity. The dairy-house should be situated on a porous soil and on the top or the declivity of a hill, or in circumstances otherwise thoroughly favourable to constant ventilation, pure air, and entire freedom from vapours and noxious gases; and it should also enjoy shelter, whether by the configuration of its site or by screens of trees, from northerly, easterly, and south-easterly winds. The principal parts of a dairy-house are the milk-room, the work-room, and the cheese-room.

The milk-house ought to be of sufficient capacity to contain one day's milk of all the cows which are kept upon the farm. It must be cool, of uniform temperature throughout the year, thoroughly ventilated, and perfectly free from damp vapours and bad smells; and it must be always kept clean, dry, and sweet-aired. In cavernous countries, it might, in some instances, be fitted up in a capacious, dry, well-ventilated natural cavern, with abundance of spring water, and an opening toward the west,—such a cavern as serves best in various countries for the storing and keeping of wine; and in some of the sandstone districts of Britain, it might be fitted up in an artificial excavation, so formed as to imitate such a natural cavern. But in all ordinary circumstances it must simply be constructed on the open ground, in such a manner or with such accompaniments as to exclude alike the excessive heat of summer and all the proper cold of winter. Its temperature in any part of the year must not rise above 55° nor fall below 50°, else it will certainly injure the milk; and this temperature can be maintained only by means of deep cooling shade in the season of intense sunshine, and of a stove, surrounding flues, or some kindred appliance, in the season of cold winds and of frost. It may be constructed either by sinking the floor some feet under ground, and making the roof a prolonged arch of stone or brick, or by having the floor on a level with the surrounding surface, and forming the roof in the ordinary manner, with a covering, not of slates or of tiles, but of straw-thatch or of turf or "divots;" and in the latter case, it ought to enjoy the shade of overhanging trees or of adjoining lofty buildings. The distance between floor and ceiling ought to be at least ten feet; the floor should be a close pavement of polished sandstone, or of tiles, with all its seams so completely puttied as to prevent the entrance or stagnation of even the smallest portion of liquid, and with a prevailing inclination toward a drain for carrying off the water; and the bench or table for holding the milk-pans should consist of polished marble, or of beech or plane-tree, or at worst of polished sandstone, and should extend round the walls—if the milk-house be a sunken one—at a line a little below the level of the outer ground, or, in any case, not more than three feet from the floor. Two windows may open toward respectively the north and the north-east, and should be covered with a sieve of brass-wire or zinc-wire, impenetratable to mice, and a sheet of gauze-cloth within the wire, such as to exclude flies and yet to admit light and a current of air. If only one window can be thus constructed, or the two be insufficient in size for abundant ventilation, air-holes, covered with wire, should be cut a little above the milk-bench and on opposite sides of the room; and if the windows cannot be opened toward the north or the north-east, but look in some other direction, each must be shaded with a board, so placed as to admit a current of air, and at the same time to exclude the rays and heat of the sun. Glazed windows may be added for the winter; yet, except in either very cold or very hot weather, they are quite useless, and ought always to stand open. "A complete ventilation," remarks Sir John Sinclair, "may be preserved by a number of narrow openings in the outside walls near the floor, covered with canvas or wire cloth, to which sliding shutters are fitted on the inside. If there is no apartment above, a ventilator should be made on the roof, covered with weather boarding, and communicating with the ceiling of the milk-room by an enclosed box or case formed betwixt the scantlings, with openings both on the under side next the ceiling, and on the upper side to the ventilator in the roof. Where there is an apartment above, the case in the ceiling should have openings at the ends through the walls, with wire-cloth coverings. Two of these cases should be made in the ceiling, with two openings to each from it, about one foot square, perforated with holes or covered with wire-cloth."

The milk-bench, the floor, and the walls of the house ought all to be so closely constructed as not to admit of the lodgment of milk, dirty water, dampness, or any impurity; the milk-bench and the floor ought to be carefully washed and dried every time that milk or water is dropped on them; the walls and the ceiling ought to be frequently swept, so that no dust may accumulate or cobwebs be formed; and the drain which carries off the water should be kept as clean as the floor itself, and should communicate, not with any sink or pond, but with an outward channel of perfectly free and open conveyance. When a little rill of water from a closely adjacent spring can be made to flow along the drain of the milk-room, it has a finely cooling and purifying effect, carrying off effluvia, keeping up continual ventilation, and maintaining constant freshness and sweetness in the air.

The work-room requires to be as near as possible to the milk-house for convenience, and yet to be sufficiently distant and separate not to communicate to the milk-house any of the steam from its boiler or of the effluvia from its floor. In many small dairy farmeries, the milk-house is situated on the north side of the building, and the work-room on the south side between the kitchen and the cow-house; but though this arrangement is convenient, it always involves injury to the contents of the milk-house, from both the steam of the work-room, and the ammoniacal vapours of the cow-house. Yet the relative position of the work-room to respectively the cow-house and the milk-house, as well as the relation of the latter to each other, must often be originally determined by the peculiarities of the site, and cannot be fully controlled by the landlord, and far less by the tenant. But the work-room, no matter how situated, must have a closely paved floor, and be kept quite clean, and perfectly free from stagnations of milk, from putrefaction of curd. from lodgments of dust, from foul vapours, and from all other kinds of impurities.

On all small farms, the work-room ought to be of ample capacity for all the operations of the dairy, both direct and subsidiary; on large farms, it ought to comprise three apartments,—one for churning, one for making cheese, and one for cleansing the utensils and vessels; in the former case, a copper-boiler must be set in brick-work in a corner of the work-room, while in the latter a larger copper-kettle must be hung on a crane in the cleansing-apartment or wash-house, for boiling water, heating milk, and other purposes requiring the use of fire; and in all cases, proper accommodation must exist for the clean, regular, and convenient keeping of the curd-vat, the milking-pails, the sieves, and the other utensils. An excellent plan, is to have, between the work-room and the scalding-house, a small open court, where the utensils may be thoroughly aired; and a plan little inferior to this is to have a door through the south side of the scalding-house, and benches on the exterior of that side, where the utensils may be placed to dry. A verandah round both milk-house and work-room is also a very desirable contrivance, shading the milk-house from the sun in summer, somewhat aiding its warmth in winter, and allowing the dairy utensils to be dried and aired in rainy weather.

The cheese-room ought, in every instance, to be a separate apartment, no matter in what part of the farmery, but clean, moderately cool, perfectly dry, and quite free from bad vapours and gases. "It ought," says Mr. Aiton, "to be dry, to have a moderate degree of air and some light, but not too much of either, and never to admit the sun to shine into it or on the cheese. If the cheeses, when laid up to dry, have not some free air, they will become mouldy, and will not dry and harden properly; and if they are exposed to much drought, heat, or sunshine, they will dry too hastily, with many cracks or fissures; perhaps they will sweat or perspire, and hove like a loaf, which in dairy language is termed fire-fanging." See the article CHEESE; and for a full notice of the operations of the dairy, see in addition the articles BUTTER, COW, MILK, and CHURN.

All milk-coolers or vessels for holding milk in the milk-house ought to be wide and shallow, so as to expose a large surface for the ascent and disengagement of the cream. Some are fixed troughs, with a stop-cock at the bottom of each, so that the milk can be withdrawn and the cream left in the trough; and these are either hewn out of stone, or made of wood with a lining of metal. But most are moveable vessels of either earthen-ware, wedgewood's-ware, wood, tinned iron, copper-work, block-tin, zinc, alloy, or some combination of wood and metal. Wooden ones are not easily kept clean; earthenware ones are easily broken; zinc, lead, and iron ones form noxious saline compounds with the lactic acid of the milk; marble ones are expensive; the other kinds also have their respective disadvantages; and probably those of wedgewood-ware, all things considered, are the most desirable. Wooden pails are used for receiving the milk as drawn from the cow; and they ought to be of sufficient capacity to contain all the milk which is obtained at one milking. The CHURN and the CHEESE-VAT have been noticed by us in articles of their own. The chief of the other utensils of the dairy are sieves of hair or of wire-gauze, for passing the milk through, in order to retain its impurities, when emptying it from the pails into the cooler; scallops, or flat dishes of horn, ivory, or willow, for skimming the cream from the surface of the milk; jars for receiving the cream, and containing it till the time of churning; a flat wooden tub for washing butter in; balance, scales, and weights, for weighing butter; covered dishes, for holding pound-pieces of fresh butter; moulds for forming prints of butter for the table; jars or firkins for the curing and packing of salted butter; a wooden vat or tub for the coagulating of milk which is to be made into cheese; a curd-cutter and curd-breaker, or knife and implement for the cutting and comminuting of the curd; and a drainer, or vessel pierced with holes, for drawing off the great body of the whey from the curd.—*Aiton's Treatise on Dairy Husbandry.—Sir John Sinclair's General Report of Scotland.—Transactions of the Highland Society.—Quarterly Journal of Agriculture.—The Farmer's Magazine.—Armstrong's Treatise on Agriculture.—Buel's Farmer's Instructor.—Low's Elements of Agriculture.—Doyle's Cyclopædia of Husbandry.—Stephens' Book of the Farm.—Knowledge Society's Farm Reports and Flemish Husbandry.—Rham's Dictionary of the Farm.*

DAISY,—botanically *Bellis.* A genus of hardy flowering plants, of the aster subdivision of the composite order. The common daisy, *Bellis perennis,* is the best known of all flowering plants, and so exceedingly abundant as not to need any description. Both its root and its leaves are perennial; and even its flowers may, under various conditions, though at times very scantily, be seen at almost any period of the year. It, therefore, well deserves the epithet *perennis;* nor does it less merit the name *bellis,* signifying 'pretty' or 'handsome.' Yet though a favourite of all children, all poets, and all unsophisticated classes of adults, it is superciliously regarded by aristocrats as a vulgar intruder upon their lawns, and is expelled or kept down by perpetual stubbing. It is also quite a weed, and an utterly wasteful one, on the pastures of the farmer; for it is not eaten by any kind of stock,—it renders every spot which it occupies, or the aggregate of its possession of a field, perfectly useless or practically barren,—and hence, whenever it exists in any considerable degree of abundance, it indicates sterility of soil, and suggests the necessity of georgical improvement. It is one of 'Flora's watches,' rolling up its florets at the approach of rain, and unfolding them at the return of sunshine. Its fond and earliest popular name was 'the eye of day,' or 'day's-eye;' and this name it still retains in the abbreviated form of daisy. It also bears the name of bairnwort, in allusion to the love which children have for it; and it is popularly called in Scotland the gowan, and in France the beautiful pearl.

The garden daisy is commonly regarded as a natural variety of the common daisy, obtained at some remote period in the field; but a very prolonged and patient effort totally fails to make the two interchange characters. The principal subvarieties are the large double red, the large double white, the piped or double quilled red, and the proliferous or hen-and-chicks. All these usually flower from March till August, and very often afford a partial and enlivening bloom in the winter months of mild seasons; and they are readily propagated by division of the root-clods. A very handsome hybrid, with white and red coloured flowers, was introduced about twenty years ago from Italy; and another perennial species and two annual species have been brought from respectively Portugal, Texas, and the south of Europe.

DAISY (OX-EYE). See CHRYSANTHEMUM.

DAISY-RAKE. A rake for tearing off the flowers or flower-buds of daisies, buttercups, and dandelions in lawns. It has two-edged teeth somewhat in the manner of lancets.

DALBERGIA. An important genus of evergreen, tropical plants, of the kidney-bean division of the leguminous order. It forms the type of a tribe or subdivision comprising six other genera. About 30 species of it are known to botanists; and about two-thirds of these, all natives of India or of the Mauritius, have been introduced to the hothouses of Britain. Some are evergreen climbers or twiners of from 15 to 25 feet in height: but the majority are evergreen trees of from 10 to 40 feet in height. The juice of the fresh root of *D. arborea*, an unintroduced species, is used by the Vytians for cleaning foul ulcers; and a fixed oil, obtained by expression from its legumes, is used for rheumatic affections and for burning in lamps. The timber of *D. acuminata*, also unintroduced, is used for making the knees and frames of ships; and that of *D. latifolia*, introduced in 1811, is used for making all sorts of household furniture.

DALEA. A large genus of plants, of the lotus division of the leguminous order. Two species from Vera Cruz and Mississippi, *D. Cliffortiana* and *D. alopecuroides*, are hardy, blue-flowered annuals; two, the silky and the nine-leaved, from Mexico and the West Indies, are small evergreen shrubs, with respectively purple and pink flowers; and most of the others are handsome herbaceous perennials, but very various in hardiness, height, and floral colour. Dalea is the name also of a Jamaica, evergreen, pink-flowered, two-yards high shrub, of the eupatorium genus.

DAM. The mother of a domestic animal; also, a bank or mole to form and retain an accumulation of water. See the article EMBANKMENT.

DAMASK ROSE. See ROSE.

DAMASONIUM. A genus of aquatic plants, of the frog-bit tribe. The star-headed species, or star-headed water plantain, *Damasonium stellatum*, but called by Linnæus *Alisma Damasonia*, and by Robert Brown *Actinocarpus Damasonium*, grows wild in ditches and other shallow stagnant waters of England. It has a height of 6 or 8 inches, floats upon the water, and carries white flowers from June till August; and it was formerly used in medicine, but has lost its reputation. Two perennial, white-flowered, floating species have been introduced from India and Australia.

DAMEWORT, or DAME'S VIOLET. See ROCKET.

DAMMAR PINE,—botanically *Dammara*. A genus of beautiful evergreen trees, of the abies division of the coniferous order. The oriental species, *Dammara orientalis*, called by Lambert *Pinus Dammara*, and by Salisbury *Agathis loranthifolia*, was introduced to the hothouses of Britain from Amboyna in 1804. It readily attains, in its native country, a height of between 50 and 60 feet; and it makes a beautiful object and acquires a half-hardy habit in Britain, by being grafted on an auracaria. Cuttings of it are easily struck in a gentle bottom heat and a moist atmosphere.—The southern species, or Cowdie pine or Kowrie pine, *Dammara australis*, grows naturally to the height of 100 feet and upwards in both the plains and the mountains of New Zealand; it yields, in large quantities, a very useful resin; and it is considered one of the finest trees of all Australasia for many economical uses, and especially for naval purposes. Young dwarf specimens of it have been grown in British hothouses during the last 25 years, and are readily multiplied from cuttings.

DAMPS. Certain deleterious gases which are extricated in mines. They are distinguished by miners under the names of *choke-damp* and *fire-damp*. The former is found in the deepest parts of mines. It extinguishes candles, and often proves fatal when it has been suffered to accumulate in large quantities. It consists, for the most part, of carbonic acid gas. The fire-damp, which prevails almost exclusively in coal-mines, is a mixture of light carburetted hydrogen and atmospheric air, which explodes with tremendous violence whenever it comes in contact with flame. The injuries which formerly occurred so frequently, both to the machinery and the lives of miners, arising from the fire-damp, are now almost completely obviated by the fine invention of Sir Humphrey Davy, the safety-lamp. It consists of a cylinder of wire gauze, about four inches in diameter and a foot in length, having a double top, securely fastened by doubling over to a brass rim, which screws on to the lamp itself below. The whole of the wire gauze is protected, and rendered convenient for carrying, by a triangular wire frame and a ring at the top. The wire gauze is made either of iron or copper, the wire being at least one-thirtieth of an inch in diameter, and woven together so as to leave 625 apertures in a square inch. The body of the lamp is of rivetted copper, or of massy cast-brass or cast-iron, the screws fitting so completely as to leave no aperture into the body of the lamp. When the lamp is lighted, it affords the miner all the light which he requires, and renders him perfectly secure, even though entirely enveloped with the explosive mixture, which, with an ordinary light, would immediately prove fatal. The first effect of the fire-damp atmosphere is to increase the length and size of the flame. When the carburetted hydrogen forms as much as one-twelfth of the volume of the air, the gauze cylinder becomes filled with a feeble blue flame, but the flame of the wick appears burning brightly within the blue flame, and the light of the wick augments until the inflammable gas increases to one-sixth or one-fifth, when it is lost in the flame of the fire-damp, which now fills the cylinder with a pretty strong light. As long as this explosive mixture of gas exists in contact with the lamp, so long it will give light; and when it is extinguished, which happens when the foul air constitutes as much as one-third of the volume of the atmosphere, the air is no longer proper for respiration; for though animal life will continue when flame is extinguished, yet it is always with suffering. A coil of platinum wire being fixed above the wick of the lamp, within the gauze cylinder, the metal continues to glow long after the lamp is extinguished, and affords a sufficient light to enable the miner to make his escape. The effect of the safety-lamp is supposed to depend on the cooling agency of the wire gauze, exerted on the portion of gas burning within the cylinder. Hence a lamp may be secure where there is no current of an explosive mixture to occasion its being strongly heated, and yet not safe when the current passes through it with great rapidity. But any atmosphere, however explosive, may be rendered harmless by increasing the cooling surface, which may be done either by diminishing the size of the apertures, or by increasing their depth, both of which are perfectly within the power of the manufacturer of the wire gauze.

DAMSON. See Plum.

DANDELION,—botanically *Leontodon*. A genus of hardy, perennial-rooted, herbaceous plants, of the chicory division of the composite order. The common species, *Leontodon taraxacum*, now sometimes called *Taraxacum officinale*, is a very common and exceedingly well-known weed of the meadows, pastures, road-sides, and ditch banks of Britain. Its root is fusiform, very juicy, externally dark-coloured, and very difficult of extirpation; its leaves are radical, runcinate, toothed, and smooth; its flower-stem is erect, fistulous, fragile, naked, smooth, about a foot high, and abounding with a milky bitter juice; its flowers are large and terminal, comprise very numerous ligulate florets, bloom from April till August, and have the habit of closing in the evening and expanding in the morning; and its seeds are obovate and furrowed, and are furnished each with a long-striped pappus or down, which causes them to be easily lifted away with a breeze of wind, and widely dispersed over surrounding tracts of land. As this weed is at once so common, so facilely propagated, and so difficult of extermination, it ought never, upon a farm, to be allowed to grow to seed. It is greedily eaten by rabbits, goats, and hogs; but is disliked by sheep and cattle, and totally refused by horses. Its roots and its leaves are eaten by many of the French people with bread and butter; and its tender leaves, grown in garden soil, earthed up, and blanched, have sometimes been used in England as a salad. A decoction of the fresh, full-grown root, in the form of extract, or simply an infusion of sliced pieces of the root, is used in medicine for jaundice, dropsy, chronic derangements of the stomach, and various diseases of the respiratory organs, the liver and the skin. The German physicians think highly of it; and many British physicians began about twenty years ago to show it considerable favour. Its popular English name is a corruption of its French name *dent de leon;* and this, as well as its botanic name *leontodon*, signifies "lion's tooth," and alludes to the form or outline of its leaves. The marsh species, *Leontodon palustris*, is a weed of the low boggy meadows of Britain; and upwards of a dozen species have been brought by curious collectors from various parts of continental Europe and western Asia. But the common species concentrates in itself the main interest of the genus.

DANDRIFF. The separated and powdery portions of the cuticle of the horse, which are raised by the curry-comb, and brushed away in grooming. The cuticle is constantly undergoing change and renewal; and, being insensible, parts with its exhausted portions, without pain to the animal, and with evident advantage to the healthiness of the skin. See the articles Cuticle, Skin, and Grooming.

DANEWORT. See Elder.

DANTHONIA. A genus of grasses, of the oat tribe. It is distinguished from the avena genus, or true oats, by its lower palea being much prolonged, two-toothed, and so deeply divided as to make the awn appear as if inserted between the teeth; and it comprises about twenty known species, three of which were formerly reckoned true oats, and one is indigenous, and nine or ten have been introduced to Britain from foreign countries.

The common, strigose, or bristle-pointed species, *Danthonia strigosa*, called by Sowerby and Smith *Avena strigosa*, grows wild by the side of hedges and in fields of oats, particularly of the later sorts, in both England and Scotland. Its root is annual; its culm, about a yard high; its panicle, nearly simple, and inclined or nodding to one side; its florets bearded, and about as long as the glumes; and its seeds, thick-skinned and rather small. It is often confounded by farmers with the wild oat, *Avena fatua;* but may readily be distinguished from that plant by its shorter culm and its nodding panicle. This species is supposed by some agriculturists to have been the originally cultivated oat of Scotland; it continued till quite a recent period to be cultivated, as a bread-corn, in the Orkney and the Shetland Islands, and in some parts of the Scottish Highlands; and it is still cultivated, both for green and for ripened fodder to cattle in several parts of continental Europe, particularly in France. An improved variety of it, more compound in its panicle, more prolific of seed, slightly lighter in colour, and known as the Argyleshire small oat, is cultivated for cattle in the vicinity of Strontian. Three of the foreign species introduced to Britain are hardy annuals; and the others are half-tender perennials; but all are devoid of interest to the farmer.

DAPHNE. A genus of ornamental shrubs, containing the wild-olive or species which constitutes the type of the natural order Thymelææ. Four of its best known and most interesting species, *D. mezereum*, *D. cneorum*, *D. thymelæa*, and *D. laureola*, will be separately noticed in the articles Mezereon, Garland-Flower, Olive (Wild), and Laurel (Spurge). About twenty other species exist in British shrubberies; and nearly as many more have been botanically described. Most of those in cultivation are evergreens, and objects of much beauty. The Pontic species, *D. pontica*, has a close general resemblance to the spurge laurel; and it includes a hybrid variety, with reddish-coloured flowers. The flax-leaved species, *D. gnidium*, has very slender branches, narrow, acutely lanceolate, flax-like leaves, and small panicled flowers. The tarton-raira or oval-leaved species, *D. tarton-raira*, has tough, irregular, numerous branches, very small, soft, shining, oval leaves, and white clustered flowers. The alpine species, *D. alpina*, has obtusely lanceolate leaves with hoary under-surface, and white, fragrant, clustered flowers. The southern species, *D. australis*, introduced about eight years ago from Naples, is remarkable for the hairiness of its stem and leaves.

DARG. The quantity of bog-turf for fuel which one man can cut and two men can wheel in one day.

DARNEL,—botanically *Lolium Temulentum*. A pernicious, deleterious, annual, gramineous weed, of the rye-grass genus. It infests the wheat-fields of Britain, and of other countries of Europe. Its seeds are about the same size as those of wheat, and are gathered with them in harvesting, and cannot, without much difficulty, be separated from them in the operations of the barn; and, when they are numerous, and find their way with the wheat into bread-flour, they prove highly noxious to man, injuring his health, and sometimes producing delirium, stupefaction, and other symptoms of poisoning. The plant has ceased to be plentiful in all good agricultural districts in Britain, and has almost disappeared in some; but it continues to be dismally prevalent in some parts of the continent, and fearfully deteriorates many an imported sample of foreign wheat. Its root is fibrous; its culm is stiff, erect, and about four feet high, and feels rough to a finger drawn upwards upon it; its spikelets are generally about the same length as the glume; and its full-grown seeds are plump and about one-sixth of an inch in length.—Some other grasses occasionally, though with very questionable propriety, share the name of darnel. The chief of these are *Lolium arvense*, *Bromus mollis*, and *Bromus secalinus*.

DATE-PALM,—botanically *Phœnix*. A genus of beautiful endogenous trees, of the palm tribe. Seven species, principally tropical, and varying in usual height from 6 to 35 feet, have, within the last 60 years, been introduced to the palm-houses of British gardens; but the main interest of the genus is concentrated in the date-bearing species, *Phœnix dactylifera*, introduced from the Levant toward the close of the 16th century. This plant inhabits the north of Africa, from Morocco to Egypt, Syria, Persia, the Levant, and India, and is also cultivated in Italy and Spain. Its fruit is an oval, soft, fleshy drupe, having a very hard stone, with a longitudinal furrow on one side, and, when fresh, possesses a delicious perfume and taste; and it forms a chief article of human food in some of its native countries, and an important article of commerce. Dates are sugary, very nourishing, wholesome, and require no preparation; but when dried, and a little old, as they usually are when imported into Europe, they are not much esteemed, and are little used in the countries where they grow. The best fruits have firm flesh of a yellow colour. They are varied, however, by culture, in size and shape: some varieties are very large, succulent, and without stones. The inhabitants of Tunis and several other countries, every year, journey in crowds, into Biledulgerid to procure dates. Almost every part of the tree is converted to some use. The wood is very hard, almost incorruptible, and is used for building. The leaves, after being macerated in water, become supple, and are manufactured into hats, mats, and baskets. The petioles afford fibres from which cordage is made. The nuts, after being burnt, are used by the Chinese, in the composition of India ink. Palm wine is made from the trunk. For this purpose, the leaves are cut off, and a circular incision made a little below the summit of the tree, then a deep vertical fissure, and a vase is placed below to receive the juice, which is protected from evaporation. The date-palm is a majestic tree, rising 60 feet and upwards; the trunk is straight, simple, scaly, elegantly divided by rings, and crowned at the summit by a tuft of very long pendent leaves. The leaves are 10 or 12 feet long, composed of alternate narrow folioles, folded longitudinally. The male and female flowers are upon different trees. The fruit is disposed in 10 or 12 very long pendent bunches. The date-palm is reproduced from the roots, or from shoots, or by planting the axil of the leaves in the earth, which is the most approved mode, as female plants may be selected, while a few males, scattered here and there, are sufficient. Care is taken to water them frequently, and to protect them from the rays of the sun till they have taken root. Plants raised by this method will bear fruit in five or six years, while for those raised from the seed, 15 or 20 years are required. When the male plant is in bloom, the pollen is collected and scattered over the female flowers. Each female produces 10 or 12 bunches every year, which, when gathered, are hung up in a dry place until so much of their moisture is evaporated as to allow of their being packed. Dates, in general, are of a yellowish colour; but some are black, some white, and others brown; some, also, are sweet, and others bitter. The time of planting is early in the spring. Situations abounding in springs are selected, the trees are placed 15 or 20 feet apart, and a little trench is dug at the root of each, which is filled with water at pleasure, by means of channels excavated in the sand. The Arabs pretend that they attain the age of 200 or 300 years. The wood, though of spongy texture, is employed for the beams and rafters of houses, and for implements of husbandry, which are said to be very durable. The pith of the young trees is eaten, as well as the young and tender leaves. A considerable traffic is carried on in these leaves, which, under the name of *palms*, are sent to Italy, to be used in the grand religious ceremonies of Palm Sunday. In Persia, an ardent spirit is distilled from the fruit; and, in many places, the stones are ground to make oil, and the paste that is left is given as food to cattle and sheep.

DATE-PLUM, — botanically *Diospyros*. A genus of ornamental and economical trees, containing the species which constitutes the type of the natural order Ebenaceæ. Two species which furnish the ebony of commerce, and one of which gives name to the Ebenaceæ, will be noticed in the article Ebony.

The Virginian species, or Pishamin plum, *Diospyros Virginiana*, is a native of Virginia, Carolina, and many other parts of North America, and was introduced to Britain in the former part of the 17th century. It is a hardy deciduous tree, and usually attains a height of about 20 feet. Its branches are irregular, whitish, and smooth; its leaves are oblong, entire, about 5 or 6 inches long, about three inches broad, and uncommonly beautiful; its flowers are inconspicuous, have a yellowish-green colour, and appear in June and July; and its fruit, like that of the medlar, is eatable when in a state of decay.

The Lotus-tree, or European Lotus, or Indian date-plum, *Diospyros Lotus*, is a native of Africa and the south of Europe, and was introduced to Britain from Italy near the close of the 16th century. It is a hardy sub-evergreen tree, and usually attains a height of about 25 feet. Its stem is erect; its young branches have a smooth whitish bark; its youngest twigs stand alternately on the twigs of the preceding year; its buds for the next year's shoots begin to swell soon after the fall of the leaf; its leaves are alternate, entire, pointedly oblong, about 4½ inches long, nearly two inches broad, pleasantly green above, and whitish below; its flowers are pitcher-shaped, yellowish-green, and uninteresting, and bloom in June and July; and its fruit appear like large black berries, and are eatable when in a state of decay. This species may be propagated either from seeds or from layers; but the former species is propagated only from layers; and most, though not all, of the other species, are propagated from cuttings.

The black-wooded species, *Diospyros melanoxylon*, is an Indian evergreen tree of about 20 or 25 feet in height, and was introduced to our hothouses about 30 years ago. Its fruit is gathered in the woods of India, and eaten by the poor Hindoo people.—The kaki or Japan kaki, *Diospyros Kaki*, is a small, evergreen, fruit-tree of Japan, usually attaining a height of 12 or 14 feet, introduced to British conservatories in the latter part of last century. The mabola-plum, *Diospyros mabola*, is an evergreen fruiting shrub, of the Philippine Islands, usually attaining a height of 8 or 9 feet, and introduced to the hothouses of Britain in 1822.—The two-coloured species, *Diospyros discolor*, is a tropical, evergreen fruit-tree of the Philippine Islands, having a height of about 20 or 25 feet, and introduced to Britain about 24 years ago.—The edible-fruited and the lobed-fruited species, *D. edulis* and *D. lobata*, are cultivated, the former in India, and the latter in China, and have both been introduced to our hothouses.—The mountain species, *D. montana*, is a small Indian evergreen tree, with a timber which is hard, durable, and variegated with dark and white coloured veins.—The glutinous species, *D. glutinosa*, yields an astringent juice, which the Hindoo fishermen use for soaking their nets in, and for smearing their boats. About 30 species have been botanically described, and upwards of 20—all fructiferous, economical, or ornamental—have been introduced to Britain.

DATISCA. A genus of perennial-rooted herbaceous plants, constituting the natural order Datisceæ. It is nearly related to the great cruciferous order; and consists of three species of coarse, hardy, hemp-looking plants, all of which, but especially *D. cannabina*, have sometimes been popularly called bastard hemp. D. cannabina is a native of Candia, and was introduced thence to Britain about the middle of the 17th century. Its stems are about 4 feet high; its leaves grow alternately on the stems, and are pinnate, each consisting of 3 pairs of long serrated leaflets and a terminating odd one; and its flowers are produced in long loose spikes from the sides of the stems, but make a very inconspicuous appearance.

DATURA. See THORN-APPLE and STRAMONIUM.

DAUCUS. See CARROT.

DAVIESIA. A genus of beautiful, evergreen, Australian shrubs, of the sophora division of the leguminous order. Their calyx is angular and five-toothed; their corolla is longer in the vexillum than in the keel; and their legume is compressed and angular, and opens elastically or with a jerk. About 15 species have been introduced to our greenhouses and conservatories. The furze-like species, *D. ulicina*, was introduced in 1792, and was, for twelve years, the only one known in Britain. Its stem is about a yard high; its branches and leaves are spinescent at the apex; its leaves are lanceolate or almost linear, and have smooth margins and a spreading habit; and its flowers are solitary, axillary, and yellow, and bloom in great profusion from April till August. This plant has a pleasing appearance in winter, and a remarkably striking one when in flower; and ought to have a place in every collection of even somewhat small extent.

DAY-LILY, — botanically *Hemerocallis*. A genus of hardy, herbaceous, evergreen, ornamental plants, constituting the type of the natural order Hemerocallideæ. This order is nearly allied to the gorgeous amaryllideæ; and consists, for the most part, of fine showy plants, with racemes or umbels of yellow, white, blue, or red flowers. It comprises 18 genera, and has, within the gardens of Britain, 9 or 10 hardy species, about 250 greenhouse species, and 15 or 16 hothouse species. Its most interesting genera to the economist are those of the day-lily and the aloe.

The day-lily genus has a bell-shaped corolla with subcylindrical tube, delicate stamens, and small, simple, villous stigma, but without any calyx. The fulvous species, *Hemerocallis fulva*, is a native of the Levant, and was introduced thence to Britain toward the close of the 16th century. Its root is fibrous; its stem is herbaceous and about 4 feet high; its leaves are long, pointed, keeled, and light green; and its flowers are copper-coloured, and bloom from June till August. Its foliage is produced in great abundance so early in the season as the middle and latter part of April; it has herbage qualities equal to the grasses of any water-meadow; it is greedily eaten by cattle, and does not communicate any unpleasant flavour to either milk or butter; and if cut down at any time between the middle of April and the middle of May, it rises again and continues to grow throughout the summer. This species would hence appear to be an excellent forage plant, especially for affording fresh and grateful food to cattle at the precise period of the year when supplies are most scanty and precarious; and it began to be recommended for economical cultivation in 1829; but it is very shy in producing seed, and has hitherto been propagable only by the slow and operose method of transplanting and dividing the roots. Two ornamental varieties of it, with respectively striped leaves and double flowers, *H. f. variegata* and *H. f. flore pleno*, are cultivated in the parterre.—The yellow species, *H. flava*, grows two feet high, and has yellow flowers; the two-rowed species, *H. disticha*, grows two feet high, and has orange-coloured flowers; and the grass-leaved species, *H. graminea*, grows about a foot high, and has light yellow flowers. These species also have a grassy-like character; but are not so productive as the fulvous species; yet the yellow species has a somewhat creeping habit of growth, and might perhaps be more easily propagated. The whole genus deserves the attention of agriculturists. The name hemerocallis may be freely yet correctly translated "the beauty of a day;" and both this name and the popular one allude to the duration of the flowers.

DEADLY CARROT,—botanically *Thapsia*. A genus of hardy, perennial-rooted, herbaceous plants, of the umbelliferous order. Two species, the fetid and the villous, natives of the south of Europe, but long ago introduced to Britain, have large, thick, fleshy, dark-skinned poisonous roots; and both of these have somewhat thick and spongy stems, and large, thick, hairy pinnate leaves. The popular name deadly carrot, and also an old popular synonyme of it, scorching fennel, allude to the acridity and poisonousness of these plants. Five or six other species, principally natives of the various shores of the Mediterranean, occur in some curious botanical collections in Britain.

DEADLY NIGHTSHADE. See ATROPA and BELLADONNA.

DEAD-HEDGE. See HEDGE and FENCE.

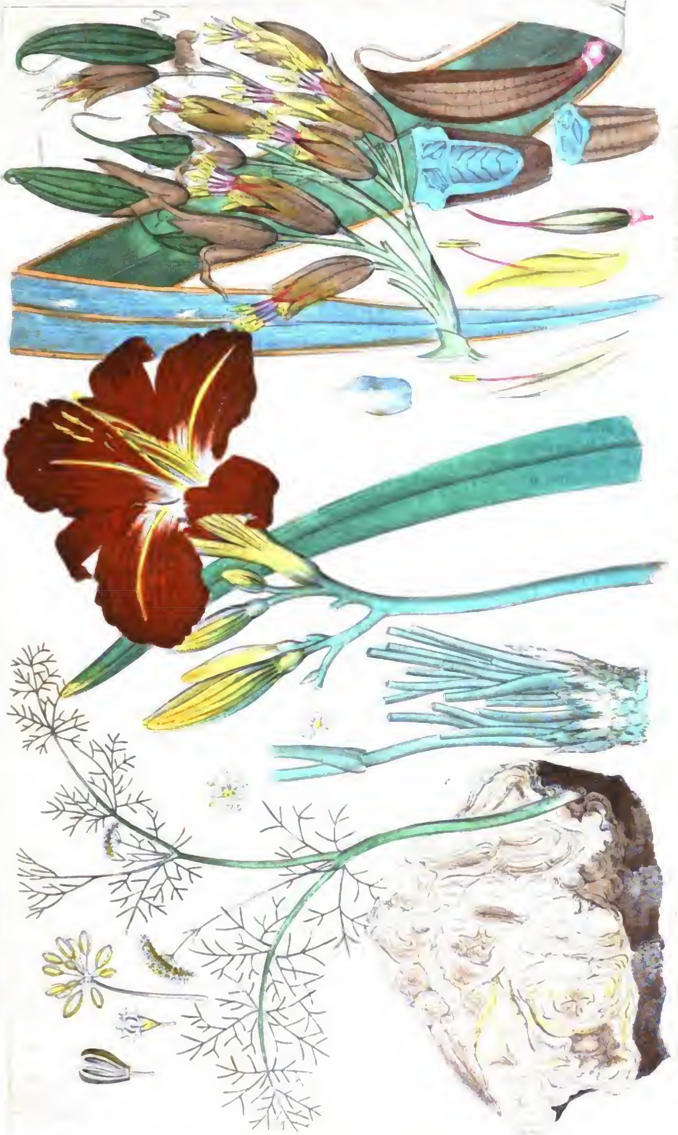
DEAD-NETTLE,—botanically *Galeobdolon*. A small genus of herbaceous plants, of the lip-flowered order. The yellow species, *G. luteum*, is a perennial-rooted weed of moist shady places in Britain. It grows about a foot high, and carries a yellow flower in May and June. When it obtains a footing in any field, no labour should be spared to extirpate it. The name galeobdolon is compounded of two words which signify "a weasel," and "fetor," and alludes to the fetid smell of this plant; and the name dead-nettle sufficiently expresses the popular opinion of it, but is often shared by an indigenous species of archangel. See the article ARCHANGEL.

DEANSTONIZING. See SUBSOIL-PLOUGHING.

DEATH-WATCH. See ANOBIUM.

DEBILITY. Feebleness in animals. It is always both an effect and a symptom of either disease or partial starvation; and it can be re-

XXVIII RECENTLY DISCOVERED PLANTS SUITABLE FOR FIELD CULTURE IN BRITAIN



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medied only by removing or alleviating its cause; so that the proper treatment for it is necessarily very varied. One of its simplest and most frequent forms is an accompaniment of dyspepsy, or a consequence of indigestion; and this may be remedied by the administration of tonics. Clater recommends for sheep suffering in this way a gentle aperient, removal to fresh and good pasture, and a table-spoonful daily of a well-prepared decoction of an ounce of gentian-root, an ounce of powdered caraway-seeds, half an ounce of calamba, and half an ounce of ginger, in a quart of water,—the daily dose to be given in a little gruel and good ale. But any equal quantity of the mere bitters, without more than a third or so of the aromatics, and without any whatever of the ale, will probably be more beneficial; and the fresh pasture alone, without any dosing whatever, except in an extreme case, will do best of all.

DEBRIS. See Alluvium and Diluvium.

DECANDRIA. See Botany.

DECAY. The natural decline, morbidity, and eventual death of perennial plants. The decay of the temporary organs, is annual, and comprehends the fall of the leaf, the fall of the flower, and the fall of the fruit of ligneous plants, and also the withering of the branches and the dying down of the stem of a large proportion of perennial herbs. The root and the organism of exfoliation—the latter consisting of the stem of ligneous plants, and of the bulb, tuber, or root-crown of herbaceous plants—are the only members which live on from year to year, or are truly perennial. But, to adopt the words of Keith, "there is a period beyond which even these permanent parts themselves begin to be affected by the infirmities of old age, as in the case of animals, and to exhibit, like them, symptoms of approaching dissolution. The root refuses to imbibe the nourishment presented to it by the soil; or if it does imbibe a portion, it is but feebly propelled and partially distributed through the tubes of the alburnum. The elaboration of the sap is effected with difficulty, as well as its assimilation when elaborated, or its descent through the wonted channel. The bark becomes thick and woody, and covered with moss or lichens, the shoot stunted and diminutive, and the fruit palpably degenerate both in quantity and in quality. The smaller or terminal branches fade and decay the first, and then the larger branches also, together with the trunk and root. The vital energy of the fabric gradually declines without any chance of recovery, and is at last totally extinguished; while the solid mass of the plant exposed to the chemical action of the surrounding substances, to which it now yields, withers, and dies away, presenting to the eye a decayed and rotten appearance, and crumbling into the dust from which it originally sprang." [Botanical Lexicon.]

DECEMBER. See Calendar.

DECIDUOUS PLANTS. Trees and shrubs which shed their leaves in autumn, or are leafless during winter. They are distinguished from evergreens, which have a full clothing of leaves throughout the year, and from sub-evergreens, which have some portion of leaves during winter, or do not cease to shed the leaves of one year before beginning to expand the leaves of the next.

DECOMPOSITION. The resolution of a compound body into its elements. It exhibits exceedingly various phenomena, and some of them not a little remarkable, such as detonation, combustion, effervescence, precipitation, and apparent annihilation; but, in every instance, it consists simply of a loosening or change of the affinities by which the elements of compound substances are held together. In the very numerous instances in which substances appear to be wholly or chiefly annihilated by decomposition, as in the detonation of gunpowder or the combustion of wood, the elements which disappear merely pass from a solid into a gaseous form, and remain in all respects as real as before, and are perfectly capable of being brought back into solid combination by the play of new affinities. But in most instances of decomposition, whether occurring quite naturally, or effected by art, new compounds are formed simultaneously with the resolution of the old ones, or the elements, in escaping from one set of affinities, are brought within the play of other sets. See the articles Affinity and Analysis. The decompositions of the atmospheric gases, of watery vapour, of saline earths, and of organic substances, and recombination of the elements of these into new forms of matter or within different sets of affinities, constitute the whole process of vegetable growth in the trees of the forest or in the crops of the farm; and the promoting of decomposition, with the view of sending the resolved elements into new combinations, constitutes the whole business of operating upon manures, soils, and plants.

But decomposition is often understood as the resolving of doubly compound substances into their proximate elements, or their simply compound parts;—and as the disintegrating of mechanical aggregations of matter into its integrants or granules,—or as first, an act or process of disintegration, and next a slow and prolonged process of resolution into proximate elements. The natural decomposition of rocks is of this last kind; and, in its successive stages, it resolves rocks into detritus, alluvium, soils, and the alkaline food of plants. See the articles Alluvium, Soils, and Alkalies.

DECORTICATION. The removing of bark from trees or of husks from grain. The former is true decortication; but the process of shelling barley, so as to convert barley grain into pot and pearl barleys, has, by a kind of prescription, been called decortication.

DECOY. A place made for catching wild-fowl. A decoy is generally made where there is a large pond surrounded with wood, and beyond that a marshy and uncultivated country. If the piece of water is not thus surrounded, it will be subjected to noises and other accidents, which may be expected to frighten the wild-fowl from the haunt, where they would otherwise sleep in the day-time. If these noises or disturbances are wilful, it has been held that an action will lie against the disturber. As soon as the evening sets in, the decoy-birds rise, as the wild-fowl feed during the night. If the evening is still, the noise of their wings, during their flight, is heard at a very great distance, and is a pleasing, though rather melancholy sound.

DEED. A written contract, sealed and delivered. It must be written before the sealing and delivery, otherwise it is no deed; and, after it is once formally executed by the parties, nothing can be added or interlined; and, therefore, if a deed be sealed and delivered, with a blank left for the sum, which the obligee fills up after sealing and delivery, this will make the deed void. A deed must be made by parties capable of contracting, and upon a good consideration, and the subject matter must be legally and formally set out. The formal parts of a deed are, the premises, containing the number, names, additions, and titles of the parties; the covenants, which are clauses of agreement contained in the deed, whereby the contracting parties stipulate for the truth of certain facts, or bind themselves to the performance of some specific acts; the conclusion, which mentions the execution and date of the deed, or the time of its being given or executed, either expressly, or with reference to some day and year before-mentioned. Every deed must be founded upon good and sufficient consideration; not upon an usurious contract, nor upon fraud or collusion, either to deceive *bona fide* purchasers, or just and lawful creditors; any of which considerations will vacate the deed, and subject the parties to forfeiture, and in some cases to imprisonment. A deed, also, without any consideration is void. A deed must be executed by the party himself, or by another for him in his presence, or with his direction; or, in his absence, by an agent authorized so to do by another deed, also under seal; and in every such case, the deed must be made and executed in the name of the principal. A deed takes effect only from the day of delivery; and therefore, if it have no date, or a date impossible, the delivery will, in all cases, ascertain the date of it; and if another party seal the deed, yet, if the party deliver it himself, he thereby adopts the sealing and signing, and, by such delivery, makes them both his own. The delivery of a deed may be alleged at any time after the date; but, unless it be sealed and regularly delivered, it is no deed. Another requisite of a deed is, that it be properly witnessed or attested: the attestation is, however, necessary rather for preserving the evidence, than as intrinsically essential to the validity of the instrument. There are four principles adopted by the courts of law for the exposition of deeds, viz, 1. that they be beneficial to the grantee, or person in whose favour they are intended to operate; 2. that where the words may be employed to some intent, they shall not be void; 3. that the words be construed according to the meaning of the parties, and the intent of the parties be carried into effect, provided such intent can possibly stand at law; 4. that they are to be expounded consonantly to the rules of law, and reasonably, without injury to the granter, and to the greatest advantage of the grantee.

DEER. These beautiful and well known quadrupeds belong to the order Pecora, or ruminating animals. They are distinguished from the antelopes by their horns, which are composed of a bony substance, caducous, or falling off annually, and again renewed of a larger size than in the preceding year. These horns or antlers always exist on the head of the male, and sometimes on that of the female. In their first or young state, they are covered by a velvet-like membrane, through which the blood circulates with great freedom. At this time, the horn is extremely sensitive, the animal suffering much pain when it is roughly handled or struck. After the horn has attained its full growth, the base becomes surrounded with an irregular, tuberculous ring, called the *burr*, and the blood-vessels gradually contract and diminish, until they cease to convey blood to the velvet membrane, which then dries, loses its sensitiveness, and finally flakes off. The form of the horns is various. Sometimes they spread into broad palms, which send out sharp snags around their outer edges; sometimes they divide fantastically into branches, some of which project over the forehead, whilst others are reared upwards in the air, or they may be so reclined backwards, that the animal seems almost forced to carry his head in a stiff, erect posture. Yet they communicate an air of grandeur, seeming like trees planted on the head of a living animal. The various species of deer, as well as the antelopes, invariably remain in their original situations, when left to themselves. Two species are common to the north of the old and new continents; five belong to North America; four to America south of the equator; four to Europe and the continent of Asia; and fourteen to India, China, and the Asiatic archipelagos.

The quantity of deer in Great Britain has, of course, diminished with the progress of agricultural improvement. During the last century, numerous forests were enclosed in England, which were formerly stocked with red deer, fallow deer, and roebucks; which, existing in an almost wild state, tempted those who lived within their range to a constant life of depredation. What the deer-stealers of the old times were, are the poachers now; and the temptation, in either case, presents a fearful cause of crime and misery. There can be little doubt that at one period of its history, probably when the surface, which is now morass or peat bog, or cleared and under tillage, was covered with forests, deer were abundant in most parts of Scotland. There was then, probably, a variety which is now extinct, for, in some of the bogs, horns are found of larger dimensions than any that are to be seen upon the present fallow deer, or the red deer of the mountains. The red deer are now far from numerous, and are seldom, if ever, seen on the Grampians. This has, no doubt, arisen from the grazing of sheep and cattle, by which the seclusion the red deer are so fond of has been broken in upon, both in the mountains and in the valleys. As the more lucrative occupation of the soil extends into the remoter districts, the race must further and further decrease; nor is the period at which they will be wholly extinct, in all probability, very distant. Red deer are yet found in Mar Forest and Glenartney; and there are still a considerable number in the west parts of Ross and Sutherland; though the extensive and judicious improvements which, very much to the general advantage of the country, have recently been effected, under the Marquis of Stafford, have made them more rare than they were about the end of the last century. Now, unless by a person whom long observation has rendered familiar with their haunts, the country may be traversed without seeing even one. From their fleetness, and the nature of the ground on which they are found, horses and hounds are of no use in the direct chase of them, as the steed would be required to leap precipices of fifty feet, instead of gates of five bars; and the dogs would be constantly tumbling into gullies and ravines, which are cleared by the deer at one bound. They cannot be driven "with hound and horn," as was the case in the days of the "barons bold;" neither can they be collected and hemmed in, after the somewhat similar manner in which the Highland chiefs conducted their sports. Still there are a few places where a person who has been habituated to the occupation, and who does not fear to ground himself in a morass, and will submit to the other pleasures of "stalking," may occasionally find a roe. The most certain time is when the state of the weather is such as to force the herds to the well heads, where there is brushwood near to cover the marksman.

The largest forest set apart for red deer which exists in Scotland is the forest of Athole, where a hundred thousand English acres are given up to them; and upon this large tract neither man, woman, child, sheep, or oxen are allowed to trespass, with the exception of those parties who are permitted to partake of the mysteries of deer-stalking. The sportsmen, seldom more than two in each party, set forth accompanied by a keeper who acts as general; and they are followed by two or three Highlanders, carrying spare rifles, and leading the deer-hounds. The party is preceded by the keeper, who is about twenty or thirty yards in advance, attentively examining the face of every hill with his telescope, to discover the deer that may be grazing upon it. Upon detecting a herd, a council of war is held, and the plan of operations determined upon. It is necessary to proceed with much caution, as, independent of the strong sense of smelling, seeing, and hearing, which these animals are endued with, there is always one of the herd, generally a hind, or female deer, stationed as sentinel; and upon the least suspicion being excited, the signal is given, and they are off. Great care is therefore taken in the approach to advance up the wind, and to conceal the party by taking advantage of the inequalities of the ground, preserving the strictest silence. It frequently happens that the sportsmen are obliged to make a circuit of some miles to get near them undetected; at other times they may find that they are in a situation from which they cannot extricate themselves unseen; in that case they must lie down till the herd move into a more favourable position for their purpose. Having arrived as near to them as is possible without detection, the sportsmen, after a careful examination of their rifles, still concealing themselves as much as possible, fire, and continue firing and loading as long as they remain within practicable distance. Eleven out of a herd of fifteen have been known to be killed by one person: the accidental circumstance of an echo, the sound being heard on one side and the flash appearing on the other, so puzzled the deer that they stood still, till the four last gathered courage and made off. When wounded, large hounds, of a breed between the greyhound and the bloodhound, are let loose upon the track of their blood, and they never leave it till they have brought the animal to bay, generally in some stream, where they keep him till the sportsman comes up and despatches him by shooting him through the head. It is necessary for the hunter to be very cautious in approaching him when at bay, and always to keep him down the stream from where he stands; for, if he breaks his bay, he is very likely to attack his pursuer, gore him with his horns, or trample him to pieces with his feet. This is, of all European sports, the most noble and interesting, as any person, who has tried and understands it, will testify, heightened as it is by the wildness and beauty of the scenery, the pure invigorating effect of the mountain air, the picturesque dress and appearance of the Highlanders, and the eager interest they take in a pursuit so peculiar to their own hills and so congenial to their habits.

Fallow deer are much more abundant in Scotland, not only in enclosed parks, but at large, over the country. They are found in many of the lowland plantations in Forfar and Perthshire; which seems to indicate that a restoration of the woods would lead to an increase of their numbers. Those that are found in the situations alluded to, have, no doubt, been produced by individuals which had escaped from the parks. In summer they are not often seen; but when the winter is severe, they sometimes invade the cottage gardens, in troops of six or eight together. In a state approaching that of nature, they are most plentiful in the central part of the Grampians, from which it is probable that they may extend their numbers into all those mountain districts, where planting has been preferred to grazing. They are most numerous on the southern part of the bleak, and, generally speaking, naked ridge of Minigny, which lies between the glen of Athole on the south, and Badenoch on the north; and between the lofty summits of Ben-y-glac on the east, and the pass of Dalnavardoch on the west. The greater part of this ridge is the property of the Duke of Athole, although many deer are found on the lands of the Duke of Gordon and others, towards the east. The deer are seldom on the summits; but generally in the glens of the Tilt and Bruar. Those deer are often seen in herds of upwards of a thousand; and when a long line of bucks appears on a height with their branching horns relieved upon the clear mountain sky, the scene is very imposing. In *Plate XXXI.* we have given figures of three species of deer, viz., *Fig.* 1, the *Cervus macrourus*, or Long-tailed deer. *Fig.* 2, the spotted variety of the *Cervus dama*, or Fallow-deer. *Fig.* 3, the Virginian fallow-deer, whose horns are arched forwards.

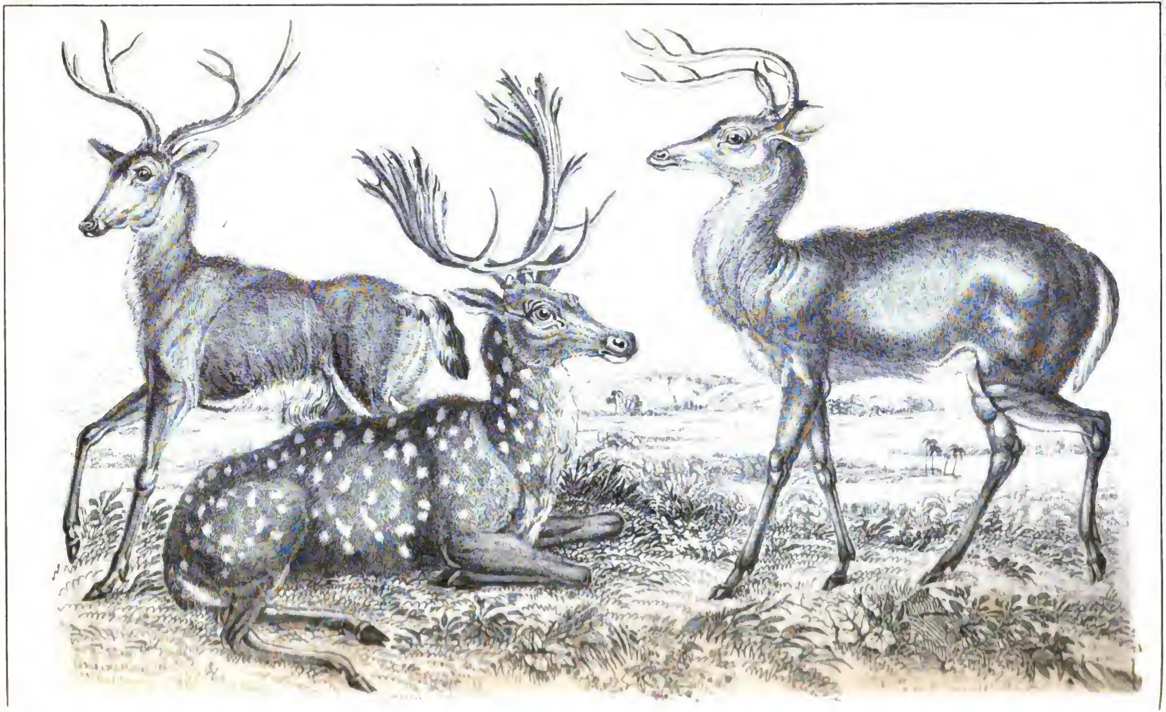
The writings of naturalists exhibit much confusion in relation to the North American species. This has arisen, in a great measure, from the loose manner in which species have been proposed on the authority of travellers, wholly incompetent to distinguish between mere varieties and those permanent characteristics indicative of specific constitution.

The *Moose*, or *Original* of the Canadians, is, perhaps, the only deer whose general appearance can be called ungraceful, or whose proportions, at first sight, impress the beholder unfavourably. Its large head terminates in a square muzzle, having the nostrils protruded over the sides of the mouth; the neck, which is furnished with a short, thick mane, is not longer than the head, which, in the males, is rendered still more cumbrous and unwieldy by large palmated horns; under the throat is an excrescence, from which issues a tuft of long hair; the body, which is short and thick, is mounted on tall legs, giving a very ungainly aspect to the animal, which is not diminished when it is in motion, as its gait is a sort of shambling trot, very efficient, however, from the great length of its limbs. The moose inhabits the northern parts of both continents. In America, it has been found as far north as the country has been explored; its southern range, at former periods, extended to the shores of the great lakes, and throughout the New England states. Du Pratz mentions that, in his time, they occurred on the Ohio. At present, however, they are seldom heard of to the south of the state of Maine, where, also, they are becoming scarce. But in Nova Scotia, around the bay of Fundy, and in the Hudson's bay company's possessions, they are found in considerable numbers. Their flesh is more relished by the Indians, and persons resident in the fur countries, than that of any other animal. It bears a greater resemblance, in its flavour, to beef than to venison. The large and gristly extremity of the nose is accounted an epicurean treat. Hearne states that the external fat is soft, like that of a breast of mutton, and when put into a bladder, is as fine as marrow. In this it differs from all the other species of deer, of which the external fat is hard. The moose attains a large size, particularly the male, which sometimes weighs eleven hundred or twelve hundred pounds. Their skins, when properly dressed, make a soft, thick, pliable leather, which the Indians prepare by scraping them to an equal thickness, and removing the hair: they are then smeared with the brains of the animal, until they feel soft and spongy; and lastly, they are suspended over a fire made of rotten wood, until they are well impregnated with the smoke.

The *Reindeer* inhabit the arctic islands of Spitzbergen, and the northern extremity of the old continent, never having extended, according to Cuvier, to the southward of the Baltic. They have long been domesticated, and their appearance and habits are well described by naturalists. The American reindeer or *caribou*, are much less perfectly known: they have, however, so strong a resemblance, in form and manners, to the Lapland deer, that they have always been considered to be the same species, without the fact ever having been completely established. The American Indians have never profited by the docility of this animal, to aid them in transporting their families and property, though they annually destroy great numbers for their flesh and hides. There appear to be several varieties of this useful quadruped peculiar to the high northern regions of the American continent, which are ably described by Doctor Richardson, one of the companions of Captain Franklin in his hazardous attempt to reach the north pole by land. The closeness of the hair of the caribou, and the lightness of its skin when properly dressed, render it the most appropriate article for winter clothing in the high latitudes. The hoofs of the reindeer are very large, and spread greatly, and thus enable it to cross the yielding snows without sinking. During the summer months, this deer feeds upon every species of green herbage; but in winter, his whole food is the lichen or moss, which he instinctively seeks under the snow. It is a singular, but now a well-established fact, that the reindeer will eat, with avidity, the lemming or mountain-rat, presenting one of the few instances of a ruminating animal being, in any degree, carnivorous. Reindeer have several times been transported to England and Scotland in large numbers, but they have invariably died, although they were attended by Laplanders, and could procure plenty of their natural food.

XXXI

DEER



Whether the failure arose, however, from a want of proper attention to the peculiar habits of the animal, or was the natural result of the tenacity with which the deer tribe adhere to their original geographical position as a law of nature, is a question not easy to be decided.

The *American Elk* was, until very recently, confounded with the moose, from its common English name being the same as that applied to the European moose. The size and appearance of the elk are very imposing; his air denotes confidence of great strength, whilst his towering horns exhibit weapons capable of doing much injury. The elk, at one period, ranged over the greater part of the American continent, and is still occasionally found in the remote and thinly settled parts of Pennsylvania; but the number is small. Doctor Richardson states that its northern range is about the 56th or 57th parallel of latitude. The elk has been sometimes domesticated to a certain degree; but, at the same time, from its warlike disposition, it is not likely that it could be advantageously substituted for the reindeer.

DEGRAPHIS. A small genus of hardy grasses, of the canary-grass tribe. The name means 'twice-marked,' and alludes to the appearance of the foliage. Only two species are known, and the one of these is classed by some botanists as an arundo; and the other by other botanists as a phalaris. See the articles ARUNDO and CANARY-GRASS.

DELPHINIUM. A large genus of hardy, herbaceous, ornamental plants, of the ranunculus order. See the article LARKSPUR. A peculiar alkaline substance, called delphia, is obtained from the seeds of *Delphinium staphisagria*. The seeds are digested in vitriolically acidulated water; a precipitate is thrown down by means of magnesia or any other alkaline earth; and this precipitate is purified by solution, digestion, and evaporation. Delphia, as thus obtained, is a white crystalline powder, of feebly alkaline power, and combining with acids to form bitter neutral salts.

DEMESNE. A park or suite of pleasure-grounds. In England and Scotland, the word is of unfrequent use and various meaning; but in Ireland, it is the current and distinctive designation of the portion of an estate which a landed proprietor retains in his immediate possession, whether consisting of a mere park, or including also home-farm, forest, and other grounds. The office of a demesne-steward is noticed in the article AGENT. See also DOMAIN.

DEMULCENT. A medicinal application which diminishes the effect of stimulating or acrimonious substances upon the sensible parts of the animal body. A demulcent either is a mere diluent, and consists wholly or principally of water, or is an oily or mucilaginous substance for lying over the sensible parts of the body like a sheath, and consists of various oils, gum arabic, gum tragacanth, or marshmallow. A demulcent is employed in veterinary practice as an expedient for preventing mischievous irritation.

DENDROBIUM. A large and very splendid genus of tropical, epiphytous plants, of the orchis order. A considerable number of species formerly included in it are now assigned to eight other genera; but between thirty and forty species still belonging to it are cultivated in the hothouses of Britain; and all these have been introduced since the commencement of the present century, and by far the greater number within the last 22 years. The majority are natives of India; and nearly all the remainder are from Australia, China, and Nepaul. The whole group are pre-eminently beautiful, and fling a profusion of ornament into every stove where they exist. The noble species, *D. nobile*, introduced from China in 1836, is one of the most gorgeous, and may be selected as a fair specimen of all. Its very stems are so bright and transparent as to form a beautiful object; the bright-green veins of its leaf-sheaths, seen through the semitransparent skin, have a striking effect; and the flowers, besides being exquisite in their tints and colourings, are unexcelled for delicacy of texture and gracefulness of form, at first nodding as if their slender stalks were unable to sustain the weight, and then disentangling themselves from their ample folds, and assuming a horizontal position, with a rich trumpet-shaped lip, and an apparently solid centre. The stems are erect, clustered, light green, a foot or upwards in height, rather compressed, with deeply furrowed joints of about three-fourths of an inch in length; the leaves are rather distichous, narrow-oblong, obliquely emarginate, firm, flat, obtuse, with thin semitransparent sheaths, which quite surround the stem at the base, and permanently clothe it after the leaves themselves fall; the peduncles are ascending, two or three flowered, bursting through the leaf-sheaths at their back, and about two inches in length; the flowers when in bud are nodding, when expanded horizontal, quite spread open, and 2¾ inches in breadth; the sepals are broadly linear, obtuse, nearly equal, and pale greenish yellow, tipped with rich bright purple; and the petals are obtusely oblong, rather wavy, transparent, very delicate, and the same colour as the sepals; and the lip is rolled up, very shortly unguiculate, downy both inside and outside, obovate with a deep notch on each side, deep blood red in the tube, pale greenish yellow on the disc and the edges, and tinged with purple at the end. Some of the finest of the other species are *D. speciosum*, with purplish flowers, blooming from June till August; *D. fimbriatum*, with yellowish flowers, in April; *D. crumenatum*, with whitish fragrant flowers, in April and May; *D. Pierardi*, with pinkish flowers, in March; *D. cucullatum*, also with pinkish flowers, in March; *D. formosum*, with ivory-white flowers; *D. Gibsonii*, with brilliantly orange and yellow flowers, from June till October; *D. amplum*, and *D. heterocarpum*. A division of the genus has pseudo-bulbous stems in the manner of *Bulbophyllum*, and may be regarded as intermediate between that genus and Dendrobium.

DENDROMETER. An instrument for measuring a growing tree. One invented by Mr. Menteith, and called an altimeter, a model of which may be seen in the museum of the Highland Society, ascertains the height by actual measurement, a wheel being made to roll up the trunk of the tree, and a little bell to strike at every foot of altitude. One, invented by Mr. Rogers of Marlborough, and described in Loudon's Encyclopædia of Agriculture and in the 6th volume of the Mechanic's Magazine, is a machine mounted on a tripod stand, and so constructed as to take angles both horizontally and vertically, and to ascertain the solid contents of the tree from the measure of the tangents. One, invented by Mr. Gorrie of the Annat Gardens, and described in the 2d volume of Loudon's Gardener's Magazine, ascertains height and girth by nearly similar means to those of Mr. Rogers' machine. But a very simple method of ascertaining the height of a trunk by actual measurement is to fit five or six rods of deal or bamboo upon one other with ferules, and in a tapering manner like the pieces of a fishing-rod; and a facile instrument for ascertaining the circumference of the trunk at different parts is Broad's callipers,—an instrument composed of two thin pieces of deal about 13 feet long, with a brass limb or index, on which are engraven figures denoting the quarter-girth in feet and inches. In using the callipers to make a measurement, "the index end is taken hold of, and the other applied to that part of the trunk where the girth is to be taken, opening it so wide as just to touch at the same time both sides of it, keeping the graduated index uppermost, on which the quarter-girth will be shown, allowing one inch in thirteen for the bark."

DENDROPHAGI. Insects which prey upon trees. See the article BOSTRICHIDÆ.

DENS CANIS. See DOG'S-TOOTH VIOLET.

DENSHARE. See BREAST-PLOUGH.

DENSHIRING, or DEVONSHIRING. An old name for the operation of paring and burning.

DENSITY. This term, strictly speaking, denotes vicinity or closeness of particles; but in mechanical science, it is used as a term of comparison, expressing the proportion of the number of equal *moleculæ*, or the quantity of matter in one body to the number of equal *moleculæ* in the same bulk of another body. Density, therefore, is directly as the quantity of matter, and inversely as the magnitude of the body. Since it may be shown, experimentally, that the quantities of matter, or the masses in different bodies, are proportional to their weight; of consequence, the density of any body is directly as its weight, and inversely as its magnitude; or the inverse ratio of the magnitudes of two bodies, having experimentally equal weight (in the same place), constitutes the ratio of their densities. No body is absolutely or perfectly full of matter, so as to have no vacuity or interstices: on the contrary, it is the opinion of Newton, that even the densest bodies, as gold, &c., contain but a small portion of matter, and a great portion of vacuity; or that they contain a great deal more pores or empty space than real substance.

DENSITY OF THE EARTH. The determination of the density of the earth, as compared with that of water, or any other known body, is a subject which has excited considerable interest amongst modern mathematicians; and nothing can, at first sight, seem more beyond the reach of human science, than the due solution of this problem; yet this has been determined, and on such principles, that, if it be not correctly true, it is probably an extremely near approximation. The first idea of determining the density of the earth was suggested by M. Bouguer, in consequence of the attraction of Chimborazo, which affected his plumb-line while engaged with Condamine in measuring a degree of the meridian, near Quito, in Peru. This led to the experiments on the mountain Schehallien, in Scotland, which were carried on under the direction of Doctor Maskelyne, and afterwards submitted to calculation by Doctor Hutton, who determined the density of the earth to be to that of water as 4½ to 1. But, in consequence of the specific gravity of the mountain being assumed rather less than it ought to have been, the above result is less than the true density, as has since been shown by Doctor Hutton and Professor Playfair, the former of whom makes it, in his corrected paper, as 99 to 20, or nearly as 5 to 1. The same problem has been attempted on similar principles, but in a totally different manner, by the late Mr. Cavendish, who found the density of the earth to be to that of water, as 5·48 to 1. Taking a mean of all these, we have the density of the earth to that of water, as 5·24 to 1, and which, as we before observed, is probably an extremely near approximation.

DENTARIA. A genus of hardy, beautifully-flowering, tuberous-rooted plants, of the cruciferous order. The bulbiferous species, popularly called coralwort, leadwort, and toothwort, *D. bulbifera*, grows wild in some moist shady woods in England, and possesses abundant beauty to be worthy of a place in the parterre. Its root has a whitish colour, a branching habit, and the toothed and coral-like appearance, alluded to in the names toothwort and coralwort; its stem is slender, weak, leafy, and about 20 inches high: its leaves have a bright green colour; its "bulbs," alluded to in the name bulbifera, and used for propagating the plant, have a scaly form and a dark purple colour, and are produced on the stem at the axillæ of the leaves; and its flowers grow in thick clusters at the top of the stem; have a large size, a reddish purple colour, and a handsome appearance, and bloom in April and May. The root, when dried, has a greater pungency than Spanish pellitory; and was formerly used as a remedy for toothache. About a dozen species, all very beautiful, have been introduced to the open flower-borders of our gardens, principally from continental Europe and North America; and some of them might probably be turned to economical account.

DENTITION. The development of the teeth of young animals. See the articles Teeth and Age of Animals.

DEODAND,—*Deo dandum*. A thing to be given or dedicated to God. Persons who have attended trials for homicide will have observed that the indictment, in setting forth the manner of the death, alleges it to have been occasioned by a blow with a certain weapon, &c., "of the value of," &c. This allegation of the value of the thing which caused the death, arose from the English law of deodands. It is provided in the Mosaical law (Exod. xxi. 28), that "If an ox gore a man, that he die, the ox shall be stoned, and his flesh shall not be eaten." So, by the law of Athens, whatever was the cause of a man's death, by falling upon him, was destroyed, or cast out of the territory of the republic. This, says Mr. Christian, in his notes upon Blackstone's Commentaries, was one of Draco's laws; and perhaps we may think the judgment that a statue should be thrown into the sea for having fallen upon a man, less absurd, when we reflect that there is sound policy in teaching the mind to contemplate with horror the privation of human life, and that familiarity even with an insensible object, which has been the occasion of death, may lessen that sentiment. This reflection, suggested by Mr. Christian in reference to the Athenian law, does not seem to be the motive for the rule of the common law of England, that whatever chattel causes the death of a person, shall be forfeited. It is an ancient doctrine mentioned by Bracton (*Omnia quæ movent ad mortem sunt Deo danda*. l. 3. c. 5), and its origin is attributed to the notion, that where a man was suddenly cut off in his sins, expiation ought to be made for the benefit of his soul; and, accordingly, the chattel, which occasioned his death, should be forfeited to the king, to be devoted by him to pious uses. The statute of 4 Edward I., st. 2, relating to coroners, provides that "horses, boats, carts, mills, &c., whereby any are slain, that properly are called *deodands*, shall be valued and delivered unto the towns," which thereupon became answerable to the king for their value; in whose behalf the sheriff might levy the amount upon the inhabitants of the town. Accordingly, in all indictments for homicide, in England, the grand-jury specify the instrument that immediately caused the death, and its value, that the king may claim the deodand; for it is no deodand unless it is so found by the jury, and hence the practice of finding the instrument and its value, in indictments in the United States, or at least in some of them, although they have no deodands. Though these forfeitures were originally incurred to the king, yet he might grant them away to the lord of the manor or territory upon which the death happened, as he was accustomed to grant the right of waifs and wrecks. The deodands have been generally so granted; and these grants may probably be the reason that this ancient singularity has so long remained a part of the English law; for the right to the forfeiture has thus become a subject of private property, and so not liable to be impaired by the legislature without compensation to the parties interested. The old books contain a good deal of quaint and curious law on this subject. It will be observed, that no distinction is made, whether the death is felonious, excusable, justifiable, or purely accidental, or whether the instrument, by which it is occasioned, belongs to the person committing the homicide or to another; for, says the Doctor and Student, if a man kills another with my sword, still the sword is forfeited; but if a person be killed by falling from a thing standing still, as a cart, it is not forfeited; if, on the contrary, a horse, ox, or other animal kill a person by its own motion, by running over him or otherwise, it is a deodand. It is said, however, that if the instrument of the death is standing still, only the part which immediately occasioned the death is forfeited; as, if one attempts to climb up the wheel of a cart that is standing still, and falls, and is thereby killed, only the wheel is forfeited; but if it be in motion, the entire cart is a deodand. Only chattels are forfeited; any thing attached to the freehold, as the wheel of a mill, or a bell hanging in a steeple, is not so; and no deodand occurs, unless the death happens within a year and a day after the accident. A sale of the article does not exempt it from forfeiture; as if a horse strikes a man, and is afterwards sold, and the man dies within the year and day, the horse is forfeited. It is not surprising that so whimsical a law should be very negligently executed; the juries are very apt to mitigate the forfeitures by finding that only some trivial thing, or only a part of an entire thing, was the occasion of the death; and the court has generally refused to interfere in behalf of the lord of the franchise, to assist him in enforcing his claim to the whole article. There are no deodands on the high seas, though it has been said, that, if a man fall overboard from a vessel in a fresh water river, and is drowned, the vessel and cargo are strictly a deodand; and the above statute of Edward I., we observe, mentions boats as one species of deodand. But in this case the jury would probably find the death to have been occasioned by the winds or the water, and would have a precedent sufficiently analogous; for the books maintain that if a man, riding over a river, is thrown off his horse by the violence of the water, and drowned, the horse is not a deodand, for the death was occasioned by the current. While we write, two bills to abolish deodands in England, and to compensate the families of persons killed by accident through neglect, as under the law of Scotland, have been brought into parliament, and will probably be placed on the statute-book of the kingdom. Deodands and the forfeiture of chattels by one of these acts ceased from and after the 12th of September, 1846; and by the other an action is declared to be maintainable against any person causing death through neglect, &c., notwithstanding the death of the person injured.

DEODARA. See CEDAR.

DESCHAMPSIA. A genus of hardy perennial grasses, of the oat tribe. It has a near affinity to the hair-grass genus. The tufted species, *D. cæspitosa*, was formerly called *Aira cæspitosa*, and is fully noticed in our article AIRA. The glomerated species, *D. glomerata*, grows wild on the Scottish mountains, has a height of about a yard, and flowers in June and July. The smooth-leaved species, *D. lævigata*, also grows wild on the Scottish mountains, and has a height of 12 or 14 inches, and flowers in July and August. About a dozen exotic species are known, and most have been introduced to Britain, but all are of very inferior interest to the farmer.

DESMANTHUS. A genus of tropical plants, of the mimosa or acacia division of the leguminous order. About twenty species are known; and more than half have been introduced to British collections. About one-third of the introduced species are aquatics; and all the others are small evergreen shrubs. The leaves of all, like those of the mimosas and the larger division of the acacias, are beautifully and compoundly pinnate; and those of the aquatic species, like those of *Mimosa sensitiva*, are sensitive. The flowers of most are white,—and of all fascicled; and this latter feature is alluded to in the name Desmanthus, which signifies "bundle-flowered."

DESMODIUM. A large genus of plants, of the hedysarum division of the leguminous order. It has a near affinity to the genus hedysarum, and comprises very many species which were formerly included in that genus. About 150 species of it have been botanically described; and 60 or upwards of these have been introduced to Britain. About one-fourth of the introduced species are hardy, perennial-rooted, herbaceous plants, principally from North America; and nearly all the others are tropical plants, principally small evergreen shrubs. One of the finest of the hardy herbaceous species, *D. canadense*, though far from being common in British collections, may be selected as a sufficient specimen of the whole genus. It abounds in North America, from Canada to the Southern States, and flowers with us in July. Its stem is erect, striated, hairy, branched, panicled, and from 18 to 24 inches high; its leaves are pinnately trifoliate; its leaflets are downy, oblongo-lanceolate, and two or three inches long; its racemes are many-flowered, terminal, and often branched; its corolla has a fine purple rose colour, with a large, speedily-reflexed, white-spotted vexillum; and its pod has generally a fine oval form, and is about an inch and a half in length.

DESTRUCTION OF CROPS. The partial or total ruin of agricultural and garden plants from bad management, meteorological agency, or the attacks of fungi, insects, birds, and vermin. Some of the chief kinds of this destruction are noticed in the articles ACCIDENTS, BLIGHT, and MILDEW.

DESTRUCTION OF SEEDS. See AGRICULTURAL SEEDS.

DEUTZIA. A genus of plants, of the philadelphus tribe. It is distinguished from other philadelpheæ by its definite stamens, by the induplicate æstivation of its corolla, and by two other and less obvious characters. *Deutzia scabra*, the first species known, is a hardy ornamental shrub, and was introduced to Britain from Japan in 1833. Its stem is about 5 feet high, and not quite strong enough to grow erect without propping; its branches have a reddish brown bark, and are but slightly angular; all its young shoots are rough with minute starry pubescence; its leaves are opposite, in pairs, dark green, rough, ovate, acuminate, and serrated; and its flowers are fragrant, white, five-petaled, and not so large as those of the snowdrop, but blooming in such numerous clusters at the tips of the branches as to be a very beautiful object, and to make a fine contrast to the dark green foliage. The rough leaves of this plant are employed by the Japanese cabinet-makers for polishing wood, in the same manner in which the stems of *Equisetum hyemale* are with us; and the whole of the living plant is grown in lines to form a beautiful live enclosure.

DEVIL-IN-A-BUSH. See FENNEL-FLOWER.

DEVIL'S-BIT,—botanically *Succisa*. A genus of plants, of the teasel tribe. It was constituted out of sixteen species of the genus Cephalaria, and two species of the genus Scabiosa. Three of its species are evergreen, Australian undershrubs; three are hardy ornamental annuals; and most of the others are hardy, ornamental, perennial-rooted herbs. The common or meadow species, *Succisa pratensis*, formerly *Scabiosa succisa*, grows wild in the woods, hedge-banks, and moist meadows of Britain, and also occurs frequently in corn-fields. Its root is blackish and tapering, and has an abrupt termination as if a piece had been bitten off; its stems are round, erect, somewhat branched, and about a foot high; its radical leaves are dark green, hairy, and about four inches long; its stem leaves are small, and grow in a pair at each joint; and its flowers have a violet or dark purplish blue colour, but are sometimes milk-white, and resemble in general appearance those of the garden scabious, and appear in August and September. The name devil's-bit was suggested by the form of the root, and alludes to an absurd and superstitious legend. The plant is of use to dyers.

DEVIL'S-GUTS. See DODDER and BINDWEED.

DEVIL'S-MILK,—botanically *Euphorbia Peplus*. An indigenous species of spurge. It is an annual, infests cultivated lands, grows 9 or 10 inches high, and flowers in July and August. Its popular name alludes to the acrid milky juice which, in common with many of the other spurges, is secreted in its stem.

DEVONSHIRING. See PARING and BURNING.

DEW. A deposition of water from the atmosphere upon the surface of the earth. The conditions under which the phenomena of dew take place are the following:—The most plentiful deposit occurs when the weather is clear and serene; very little is ever deposited under opposite circumstances. It is never seen on nights both cloudy and windy. It is well known, likewise, that a reduction in the temperature of the air, and of the surface of the earth, always accompanies the falling of dew, the surface on which it is deposited being, however, colder than the air above. These phenomena admit of an easy and elegant explanation from the well-known effect of the radiation of caloric from bodies. This radiation constantly taking place in all bodies, it is obvious that the temperature of any body can remain the same only by its receiving from another source as many rays as it emits. In the case of the earth's surface, so long as the sun remains above the horizon, it continues to receive as well as to emit heat; but when the sun sinks below the horizon, no object is present in the atmosphere to exchange rays with the earth, which, still emitting heat into free space, must, consequently, experience a diminution in its temperature. It thus becomes not only many degrees cooler than in the day-time, but also cooler than the superincumbent air; and, as the atmosphere always contains watery vapour, this vapour becomes condensed on the cold surface; hence the origin of dew, and, if the temperature of the earth is below 32°, of hoar-frost. And since the projection of heat into free space takes place most readily in a clear atmosphere, and is impeded by a cloudy atmosphere, it is under the former condition that dew and hoar-frost are formed; for if the radiant caloric, proceeding from the earth, is intercepted by the clouds, an interchange is established, and the ground retains nearly, if not quite, the same temperature as the adjacent portions of air. Whatever circumstances favour radiation favour also the production of dew; and, accordingly, under the same exposure, dew is much more copiously deposited on some surfaces than on others. Gravel walks and pavements project heat and acquire dew less readily than a grassy surface. Rough and porous surfaces, as shavings of wood, take more dew than smooth and solid wood. Glass projects heat rapidly, and is as rapidly coated with dew. But bright metals attract dew much less powerfully than other bodies. Water, which stands at the head of radiating substances, is seen to condense the vapour of the superincumbent air in such a manner as to create thick mists and fogs over its surface. The unusual abundance of precipitated moisture over ponds and streams is attributable, however, not merely to the inferior temperature of their waters to the air, arising from radiation, but to the circumstance that more moisture is ordinarily contained in such air, since the sheltered situation it enjoys prevents its being borne away by those aërial currents prevailing elsewhere. An acquaintance with the cause which produces dew and hoar-frost enables us to understand the *rationale* of the process resorted to by gardeners to protect tender plants from cold, which consists simply in spreading over them a thin mat or some flimsy substance. In this way, the radiation of their heat to the heavens is prevented, or, rather, the heat which they emit is returned to them from the awning above, and they are preserved at a temperature considerably higher than that of the surrounding atmosphere. To insure the full advantage of this kind of protection from the chill of the air, the coverings should not touch the bodies they are intended to defend. Garden walls operate, in part, upon the same principle. In warm climates, the deposition of dewy moisture on animal substances hastens their putrefaction. As this usually happens only in clear nights, it was anciently supposed that bright moonshine favoured animal corruption. This rapid emission of heat from the surface of the ground enables us to explain the artificial formation of ice, during the night, in Bengal, while the temperature of the air is above 32°. The nights most favourable for this effect are those which are the calmest and most serene, and in which the air is so dry as to deposit little dew after midnight. Clouds and frequent changes of wind never fail to interrupt the congelation. The enclosures formed on the ground are four or five feet wide, and have walls only four inches high. In these enclosures, previously bedded with dry straw, broad, shallow, unglazed pans are set, containing water. Wind, which so greatly promotes evaporation, prevents the freezing altogether; and dew forms, in a greater or less degree, during the whole of the nights most productive of ice. The straw is carefully preserved dry, since if, by accident, it becomes moistened by the spilling of water, it conducts heat, and raises vapour from the ground, so as greatly to impede the congelation. The radiation from the earth's surface is one of those happy provisions for the necessities of living beings, with which nature everywhere abounds. The heavy dew which fall in tropical regions are, in the highest degree, beneficial to vegetation, which, but for this supply of moisture, would, in countries where scarcely any rain falls for months, be soon scorched and withered. But, after the high temperature of the day, the ground radiates under these clear skies with great rapidity; the surface is quickly cooled, even to a great extent, and, as soon as this refreshing cold is produced, the watery vapour, which, from the great daily evaporation, exists in large quantities in the atmosphere, is deposited abundantly. This deposition is more plentiful, also, on plants, from their greater radiating power; while, on hard, bare ground and stones, where it is less wanted, it is comparatively trifling. In cold climates, the earth, being cold and sufficiently moist, requires little dew; accordingly the clouds, which are so common in damp and chilly regions, prevent the radiation of heat: the surface is thus preserved warm, and the deposition of dew is, in a great measure, prevented.

DEWBERRY,—botanically *Rubus Cæsius*. An indigenous, deciduous, trailing, fruiting plant, of the bramble genus. It grows wild on the borders of moist fields, and in other similarly moist situations in Britain, and throughout most of continental Europe. Its stems are weak, slender, prickly, and trailing; its leaves are large, trifoliate, and dusky green; its flowers are whitish, and come out from the ends and sides of the branches in July and August; and its fruit is large and bluish, has a glaucous bloom or waxy secretion of a dew-like appearance, alluded to in its popular name, and abounds in a juice from which an excellent wine can be made.

DEWLAP. The fleshy membranaceous substance which is pendant on the throats of cattle.

DEWRETTING. The exposing of flax or hemp to the influence of the dews, by spreading it out on grassy ground, with the view of accelerating the separation of the fibre from the feculent matter.

DEWSTONE. A variety of limestone which abounds in Nottinghamshire and in some of the more northern counties of England.

DIABETES. A morbid copiousness of urine. It is usually occasioned by diuretic stimulus upon the kidneys, either in sensequence of overdosing with diuretic medicines, or of the use of too powerfully diuretic food, such as mow-burnt hay and various green plants or parts of plants browsed from the fields and hedges; and it is sometimes caused also by hard labour, old surfeits, or prolonged sickness. It usually begins with mere copiousness and frequency of urinary discharge; it proceeds to a very immoderate flow of urine, most frequently limpid like water, but sometimes turbid or whey-like; and, in its worst form, it involves a prodigious discharge of urine, and is accompanied with insatiable thirst, sickly appetite, dryness of the mouth, considerable feverishness, and rapid emaciation and loss of strength. It ought to be combated, first and chiefly, by the careful investigation and thorough removal of its causes; next with a diet of wheat,
barley, or ground beans, occasionally and slightl
intermixed with carrots, beet, or similar food
and next, by the administration of lime wate
and of diaphoretics and tonics. If the case b
recent, a ball of one drachm of opium, two drachm
of powdered ginger, and half an ounce of yello
Peruvian bark, with a quantity of syrup sufficier
for amassment, may effect a cure; but if the ca
be prolonged and violent, and have either resiste
this medicine and ordinary diaphoretics and t
nics, or been aggravated by neglect or bad trea
ment, it will require much nicety and complic
tion of management, and, unless promptly con
mitted to the care of a skilful veterinary surgeo
will very probably prove fatal.

DIABLE. A French machine for moving fro
place to place orange trees and other large a
heavy plants growing in large boxes. It is lo
and four-wheeled, and is provided with means f
lifting the heavy box 8 or 12 inches vertical
from the ground, and for retaining it there duri
the time of its being wheeled to another sp
The machine is figured and described in the 5
volume of Loudon's Gardener's Magazine.

DIADELPHIA. See Botany.

DIAGNOSIS. An examination of the sym
toms of a sick animal, with the view of ascertai
ing the precise nature and the present conditi
of its disease. This is both the most difficult a
the most important exercise of medical skill.
comparatively small amount of study may ena
any man to select the proper remedy for each
the numerous diseases to which the domestic a
stock animals of a farm are usually subject;
prolonged study, considerable experience, and
some cases penetrating judgment, are requis
for correct diagnosis.

DIAMETER. The straight line drawn throu
the centre of a circle, and touching the two
posite points of the circumference. It thus
vides the circle into two equal parts, and is
greatest chord. The *radius* is half this diame
and consequently the space comprehended
tween the centre and circumference of a circ

DIAMOND. The hardest and most valu
of all the gems. To the account of the diam
already given in the article Carbon, we will
add at present, that diamonds are of various
ours; but the colourless, which is the sort mo
used in the arts, is, when pure, perfectly cl
and pellucid as the purest water. Hence
phrases, the *water* of a diamond, a diamon
the *finest water*, &c. The colourless diam
are not, however, the most common. The ra
colours are blue, pink, and dark brown; but
low diamonds, when the colour is clear and e
throughout, are very beautiful and much val
Pale blue diamonds are also very fine and
but deep blue still more rare. The largest
mond hitherto found is in the possession of
rajah of Mattan, in the island of Borneo, w
it was found about eighty years since. It we
three hundred and sixty-seven carats. It i

scribed as having the shape of an egg, with an indentation near the smaller end. Many years ago, the governor of Batavia tried to purchase it, and offered in exchange one hundred and fifty thousand dollars, two large brigs of war, with their guns and ammunition, and other cannon, with powder and shot. But the rajah refused to part with a jewel, to which the Malays attach miraculous powers, and which they imagine to be connected with the fate of his family. This diamond is mentioned in the memoirs of the Batavian society. The diamond is the hardest of all known substances. Nothing will scratch it, nor can it be cut but by itself. By cutting, it acquires a brilliancy and play of lustre that much augment its price. The hardness of the diamond was well known to the ancients; its name, both in Greek and Latin (*αδαμας*, adamas), implying invincible hardness. The ancients did not confine the word *adamas* to indicate the diamond alone, but applied it to other hard and *adamantine* substances. They were unacquainted with the art of cutting the diamond, satisfying themselves with those which were polished naturally; but knew of the property of its powder or dust for cutting, engraving, and polishing other stones. The art of cutting and polishing the diamond was unknown in Europe till the fifteenth century. Before that period, rough and unpolished ones were set as ornaments, and valued according to the beauty and perfection of their crystallization and transparency. This art is said to have been invented and first practised in 1456, by Louis de Berquen, a native of Bruges. Charles the Bold, duke of Burgundy, was one of the first princes of modern times who affected a great splendour in diamonds. Among engraved or sculptured diamonds is one with a head, which Gori falsely imagined to be antique, and called it a portrait of Posidonius. It belonged to the duke of Bedford. Lessing thinks that many of the engraved antique gems, which are called diamonds, are nothing but amethysts, sapphires, and emeralds, deprived of their colour by the operation of fire. Diamonds are valuable for many purposes. Their powder is the best for the lapidary and gem engraver, and more economical than any other material for cutting, engraving, and polishing hard stones. Glaziers cut glass with them; glass cutters looking-glasses, and other articles of window and plate glass. The glazier's diamond is set in a steel socket, and attached to a wooden handle about the size of a thick pencil. It is very remarkable, that only the point of a natural crystal can be used; cut or split diamonds scratch, but the glass will not break along the scratch, as it does when a natural crystal is used. An application of the diamond, of great importance in the art of engraving, has been also made within a few years, to the purpose of drawing or ruling lines, which are afterwards to be deepened by aqua fortis. Formerly steel points, called *etching needles*, were used for that purpose; but they soon became blunt by the friction against the copper, so that it has always been impracticable to make what are called *flat* or *even* tints with them; such as the azure parts of skies, large architectural subjects, and the sea in maps; but the diamond, being turned to a conical point, or otherwise cut to a proper form, is not worn away by the friction of the copper, and, consequently, the lines drawn by it are all of equal thickness. The diamond etching points are turned in a lathe, by holding a thin splinter of diamond against them as a chisel.

DIANDRIA. See Botany.

DIANELLA. A genus of tuberous-rooted, ornamental, greenhouse plants, of the asphodel order. They naturally grow in woods, and are therefore named after Diana, the mythological goddess of the woods. Seven or eight species have been introduced to Britain from Australia, and two from India; and several more are known. All the introduced species, except one, have blue-coloured flowers; and the greater number bloom in the beginning of autumn.

DIANTHUS. A large and superb genus of ornamental plants, containing the carnation or type of the natural order Caryophylleæ. About one hundred species of it, besides the innumerable varieties and the several hybrids of the carnation and the garden pink, exist within Great Britain; and all are beautiful, most are deliciously fragrant, and many are inexpressibly exquisite. The name dianthus signifies "the divine flower," and particularly alludes to the beauteous form, the magnificent colouring, and the luscious perfume of the carnation. The three best-known species, with their varieties and hybrids, are the subjects of our articles Carnation, Pink, and Sweet-William. Six species grow indigenously in Britain; the great majority of the introduced exotic species are small herbaceous evergreens; five are slightly tender evergreen undershrubs; and about 40 known species, natives of different climes from our own, have not yet been introduced. We can afford space here for only the briefest possible notice of our native species.

The Armeria, *Dianthus armeria*, is an annual, and grows wild in the gravelly pastures of some parts of England, and has frequently a place in gardens. Its stem is about a foot high; and its flowers have a red or pink colour, and naturally bloom from July till September.—The proliferous species, *D. prolifer*, is also an annual, and a native of some of the gravelly pastures of England, and frequently figures among garden annuals. Its stem is about 9 inches high; and its flowers have a pink colour, and naturally bloom in July and August.—The delta-like species, *D. deltoides*, is a herbaceous perennial, and grows wild in some gravelly pastures of both England and Scotland. Its stem is about 9 inches high; and its flowers are flesh-coloured, and bloom from June till October.—The glaucous-leaved species, *D. glaucus*, is also a herbaceous perennial, and a native of some gravelly pastures of Britain. Its stem is only 3 or 4 inches high; and its flowers are white, and bloom from June till October.—The grey species, *D. cæsius*, is a herbaceous perennial, of some rocky situations in both England and Scotland. Its stem is about 4 inches high; and its flowers are flesh-coloured, and appear in June and July.

DIAPENTE. A tonic compound formerly much used in farriery. It consisted, for a time, of equal parts of gentian root, bay berries, birthwort, myrrh, and shavings of ivory; and it afterwards consisted only of the first, second, and third of these ingredients. But in the practice of all enlightened farriers, it is quite superseded by simpler and better tonics.

DIAPHORETIC. A medicine or medicinal appliance which keeps the pores of an animal's skin open, and promotes both its sensible and its insensible perspirations. The best diaphoretics for the horse are warm clothing and good grooming; and these, with sometimes the aid of exercise, are usually necessary to bring out a full or even tolerable effect from internally administered diaphoretics. Hot stimulating drugs, combined with opiate and antimonial preparations, are useful diaphoretics in some instances in which the horse is feeble and hide-bound, and has a rough dry coat; but antimonial preparations alone are almost the only diaphoretics which can with safety be given him internally in cases of fever.

DIAPHRAGM. A large, robust, muscular membrane or skin, placed transversely in the trunk, and dividing the chest from the belly. In its natural situation, the diaphragm is convex on the upper side towards the breast, and concave on its lower side towards the belly; therefore, when its fibres swell and contract, it must become plain on each side; and consequently the cavity of the breast is enlarged, to give liberty to the lungs to receive air in inspiration; and the stomach and intestines are pressed for the distribution of their contents; hence the use of this muscle is very considerable. It is the principal agent in respiration, particularly in inspiration; for, when it is in action, the cavity of the chest is enlarged, particularly at the sides, where the lungs are chiefly situated; and, as the lungs must always be contiguous to the inside of the chest and upper side of the diaphragm, the air rushes into them, in order to fill up the increased space. In expiration, it is relaxed, and pushed up by the pressure of the abdominal muscles upon the viscera of the abdomen; and, at the same time that they press it upwards, they pull down the ribs, by which the cavity of the chest is diminished, and the air suddenly pushed out of the lungs.

DIARRHŒA. A relaxed condition of an animal's bowels. It is sometimes a mere successful effort of the constitution to get rid of matter which would be injurious to health; and sometimes arises from a temporary or stimulated over-action of certain of the digestive organs; and in neither of these cases is it to be regarded as a disease. But in most instances, it is truly morbid; and in some, it is not a little dangerous. It differs from dysentery in being merely a relaxation, and not an inflammation, of the mucus membrane of the intestines,—in having its seat principally in the small bowels, while dysentery has its seat principally in the large bewels,—in causing a discharge more copious, very liquid, and without any glairy mucous matter,—in causing, from its very commencement, a free or copious purging,—and in being usually unaccompanied, in its early stages, with much fever or with any other considerable disturbance of the health. Dysentery, it may be inferred, therefore, is generally the more dangerous disease of the two. See the article Dysentery. Diarrhœa, regarded physiologically, is an acceleration in the peristaltic motion of the bowels, accompanied with increased secretion of fluid matter in the intestines, or with a morbid inaptitude in the absorbent vessels to take up the due proportion of liquid from the mass which passes into the intestines from the stomach.

Diarrhœa in horses is not very frequent in occurrence, and seldom serious in character or difficult of cure. It is occasioned variously by constitutional weakness in the bowels, by lightness and smallness in the organic structure of the belly, by the drastic effect of over-purging with medicine, by a suppression of perspiration, by imperfect assimilation of food, by great and sudden change of diet, by over-secretion of bile, and, in a less degree and more infrequently, by some other causes. When the disease is constitutional, it must be palliated by a gentle and constant antagonism upon its peculiar causes,—whether in the form of moderating drink, moderating labour, or tonically strengthening the digestive organs; when it arises from any ordinary temporary cause, it may generally be cured by change of diet and an increase of warmth; and when it is either very violent or much prolonged, it must be subdued by means of astringents, first by the mouth, and then, if need be, by injection. The best astringents are powdered catechu, prepared opium, prepared chalk, and common alum; but the last of these ought not to be used in any but the very worst cases, and the others should be administered in some such emollient substance as thin boiled starch or arrow-root.

Diarrhœa in cattle is much more frequent and dangerous than in horses, and is distinguished by veterinary nosologists into acute and chronic, the former sudden and active, and the latter slow and of long continuance. Acute diarrhœa occasions an almost constant discharge of slimy, frothy fæces intermixed with half-digested food; and is caused by eating unwholesome herbage, by sudden change of temperature, by passing in a heated state into cold water, by lying out in cold or damp weather, by fatigue in travelling, or by any similarly acting circumstance; and it ought to be treated by comfortably housing the animal, and administering a mild purgative, and, in bad cases, by moderate bleeding and the administering of alkalies and astringents. Chronic diarrhœa occasions a frequent discharge of liquid, fetid, frothy, and somewhat dark-coloured fæces, and gradual but steady emaciation of the region of the eyes and of the whole frame; and is caused by foul food, undue exposure, over-fatigue under feeding, exhaustion from excessive suckling of calves, and similar circumstances; and requires great nicety of treatment, and sometimes a change or series of remedial measures, but chiefly the cautious use of mild aperients to carry off irritating secretions or obstructions, the administration of mercurials and tonics to correct the morbid action of the liver, the judicious exhibition of astringents to act upon the relaxed mucous membrane of the intestines, and the restriction of the diet to hay, gruel, bean-meal mash, and the driest and choicest pieces of pasture.

Diarrhœa is a very common disease of calves of from two to six weeks old, and not unfrequently proves fatal. It is generally occasioned either by undue exposure to the weather, by sudden and injudicious weaning, or by first half-starvation and next a half-surfeit. The fæces, from the very commencement of the disease, contain an excessive proportion of mucus, and they afterwards become fetid and bloody; and the animal ceases to have appetite, staggers in its walk, and rapidly loses flesh. The common treatment, and in general the only thing done, is to give chalk; but this either does not cure the disease or cures it so slowly and bunglingly as to permit serious damage to the general health and perhaps to the constitution. A mild purgative, such as two ounces of castor oil, should be administered; a proper proportion of opium should, in every case, be given with the chalk; and, in all bad cases, a combination of astringents, aromatics, and carminatives ought to be given by mouth, and a glyster of thick gruel with a proper commixture of opium given by injection.

Diarrhœa, among sheep, attacks principally hoggs and two-year-old sheep, occurs almost always between February and June, is accompanied with increase of appetite, and, unless in weak and sickly animals, rarely proves fatal. A cure may, in general, be easily effected by means of astringents. But among lambs of from a day to a week old, diarrhœa is both frequent and dangerous; and it is often caused by bad treatment, and may generally be prevented by affording lambs proper shelter and comfort. The best remedies for it are warmth and new cow's milk, aided, in all bad cases, by astringents and tonic carminatives. When no cause of it can be discovered, the ewe's milk may be concluded to be faulty; and then the ewe should be physicked and removed to better pasture,—and if this should not effect a cure, the lamb should be taken from her, and fed with boiled cow's milk, containing a little prepared chalk.—Diarrhœa is not uncommon among poultry; and is usually caused by too soft food, and may generally be cured by feeding with whole wheat or with rice. —*White's Veterinary.—Blaine's Veterinary Art.—Clater's Cattle Doctor.—Youatt on Cattle.—Journal of the Royal Agricultural Society of England.—Knowledge Society's Treatise on Cattle.—Mackenzie on Sheep.—Spooner on Sheep.*

DIASTASE. A nitrogenous substance contained in malt. It is formed from gluten, is soluble in water, and possesses the power of converting starch first into dextrine, and next into grape sugar.

DIBBLE. A setting-stick, or small hand tool to make holes in the soil for setting seeds or small plants. It is used in the kitchen garden for planting beans, transplanting cabbage, and all similar operations; and in the field for setting wheat, for planting beans, and for transplanting cabbages and Swedish turnips. It may either be of rude form, such as a tapered upper part of an old spade handle, or of neat form and enduring structure, such as a conical piece of iron, fitted with a short, upright, cross-barred handle. Dibbling machines for field use have, at various periods since 1806, been invented and patented; but none of those invented previous to 1840 so far answered expectation as to recommend themselves to general adoption or to permanent favour. One of the best of these for grain is a hand dibbling machine, presented to the Highland Society in 1835, by Mr. C. Wilton of Wicham-Market. This consists of a line of blunt dibbles each attached to a shank, and an equal number of seed-boxes and spoons; and when it is lifted, the spoons dip into the seed-boxes, and are filled; and when the dibbles are pressed into the ground, the spoons rise and discharge their contents through the funnels into the line of previously formed dibble-holes. One of the best for mangel-wurzel is a two-wheeled machine, with handles fixed in the manner of a barrow, and with dibs set on the circumference of the wheels. The diameter of each wheel is 3½ feet, the breadth of each is 3½ inches; the distance between the two, or the intermediate length of the axle, may be anything not exceeding 34 inches; the distance between every two dibs on the circumference of the wheels may be either 14½, 16½, or 18½ inches; and each dib is 2 inches in length, and 1½ inch broad at the base, and tapers conically to a point. This machine is figured and described in the 3d volume of the Journal of the Royal Agricultural Society of England. But a seemingly better one, invented by Mr. Newberry of Hook-Norton, is very favourably reported on, though neither figured nor described, in the 4th volume of that Journal.

DIBBLING. The transplanting of young vegetables, or the setting of beans, grain or other seeds, by means of the hand-dibble or of a dibbling-machine. The dibbling of vegetables and of beans may be regarded as strictly routine culture, and requires no special remark. The dibbling of grain, particularly of wheat, is practised generally in Norfolk, Suffolk, and the light parts of Essex, and either occasionally or stated in numerous other districts of Britain. It began to excite attention about the middle of last century; it has been the subject of much and interesting discussion; and, though generally admitted to possess advantages of a more or less decided kind in certain combinations of circumstances, it continues to provoke variety and conflict of opinion. It differs from drill-sowing in separate holes being made for the reception of the seeds, and in the grains being dropped, not singly, but in groups of from four to seven; it saves at least a bushel of seed per acre; and, when properly performed, it lodges the seeds at regular intervals and at uniform depths, and occasions a more equable extraction of nourishment from the soil, and a much more uniform aeration among the plants, than can result from either the broadcast or the drill methods of sowing. But it is slow of performance, and consequently ill-suited to the haste and exigencies of a critical seed-time; it admits of undetected bad work, the overcharging of some holes, the undercharging of others, or the total omission of many, on the part of careless or unfaithful work-people employed to drop the seeds; and it is totally unsuited to every kind of adhesive soil, and indeed to all kinds of soil except the most friable, for particles in any degree adhesive are thrust into compactness by the dibble, and do not fall properly round the seeds, but allow the dibble-holes to act as a sort of cup for the retention of moisture and the rotting of the seeds.

Many persons insist that dibbled crops on even perfectly suitable lands are not perceptibly superior to drilled crops; and others, not only assert their growth to be more vigorous, their culms to be stronger and less liable to be lodged, and their seeds to be plumper and heavier, but estimate them to have a superior produce in measured grain varying from two to twelve bushels per acre. Diversities of opinion may probably have arisen, in some degree, from diversities in the suitableness of soils, and in a still greater degree from diversities in the care and faithfulness of the work-people employed in dropping the seeds into the dibble-holes; and were all experiments to be conducted on thoroughly friable soils, and by means of well-constructed dibbling-machines, all opinions might probably come to be pretty nearly agreed. The reporters, five in number, on Mr. Newberry's dibbling-machine in the Journal of the Royal Agricultural Society of England, say, "We have examined the effect of Mr. Newberry's dibbling-machine, and have no hesitation in reporting the superiority of the wheat-crops where the seed had been planted by that instrument over those which have been sown broadcast or drilled. We had many opportunities of comparing, side by side, the produce of these several modes of treatment; and, in every instance, found the dibbled wheat to be much longer and stronger in the straw, finer in the head, and much more free from diminutive ears; it was also much less lodged; we attribute this to the pressure of the rim or iron roller of the dibble giving the seed a firmer bed, sufficient grains being placed in each hole to guard against contingencies and supply the crop; but as vegetation advances, each plant having space to expand, and thus to derive more nourishment from the soil and atmosphere than those which are placed more thickly in the drills. We found that the machine deposits the seed very regularly, at the distance of 6 inches; both the quantity in each hole, and the distance between the rows can be easily regulated by the person using the implement; one bushel and a peck per acre Mr. Newberry recommends, and we believe it to be amply sufficient. In corroboration of our opinion, we have received several letters from farmers who have tried this instrument both on heavy and light soils, stating that they have saved one bushel per acre in the seed, with a prospect of a much larger advantage from the increased produce. We think also the dibbler is likely to become of general use in the planting of beans, as it will enable the farmer to clean them more perfectly."

DICLIPTERA. A genus of ornamental exotic plants, of the acanthus order. About a dozen species have been introduced to Britain; and about as many more have been scientifically described. The introduced species are principally natives of the tropics, and require to be treated as stove-plants; and two of them are annuals, and most of the remainder are evergreen undershrubs; two have blue flowers, two red, and most of the others purple. The name dicliptera signifies "double-shutting," and alludes to the peculiar form of the valvular fruit.

DICOTYLEDONOUS PLANTS. Plants whose seeds have two cotyledons or seed-lobes. They constitute the greater and more perfect of the two grand divisions of cotyledonous and phænogamous, or vascular plants, and are called dicotyledons in reference to the conformation of their seeds, and exogens in reference to the manner in which they form their increments of growth. See the articles COTYLEDON and EXOGENS.

DICTAMNUS. See FRAXINELLA.

DIDYNAMIA. See BOTANY.

DIELYTRA. A genus of hardy, herbaceous, ornamental, perennial-rooted plants, of the fumitory tribe. Nine species, principally natives of Siberia and North America, are known and have been introduced to Britain; most have a height of from 9 to 14 inches; three have white flowers, three flesh-coloured, two purple, and one pink; and several were formerly included in the genera fumaria and corydalis. The name dielytra signifies "double-sheathed," and alludes to the conformation of the base of the flowers.

DIERVILLA. A hardy, deciduous, ornamental shrub, of the honeysuckle order. It constitutes a genus of itself, with the specific name *Lutea* or *Canadensis;* but it was formerly included among the loniceras, under the name of *Lonicera diervilla;* and it has sometimes been popularly called the Acadian honeysuckle. It is a native of North America, and was introduced to Britain in 1739. It is a pleasant plant in a shrubbery, and has the recommendation of being exceedingly hardy. Its usual height is about 3 or 4 feet; its branches are few, comparatively large, and very full of pith,—and, when broken, they emit a strong fragrance; its leaves are opposite, shortly petiolate, oblongo-cordate, finely serrated, smooth and beautifully green above, paler below, nearly three inches long, and about 1½ inch broad; and its flowers grow in bunches, are yellow and inconspicuous, and appear in June and July.

DIET. The kind and quantity of food habitually used, for any length of time, by man or by the domestic animals. The strength and health of the horse, just as truly as those of the human subject, are exceedingly dependent on propriety and regularity of diet. See the articles FOOD, HORSE, and CALENDAR.

DIGESTION. Whatever may be the nature of the food, or in whatever animal it may be deposited, the alimentary mass accumulated in its stomach usually remains there one or more hours before any considerable alteration can be perceived. After that, the aliments begin to soften, to change their colour, and often their smell. With the exception of those grains which are entirely covered by an insoluble epidermis, the change begins on the surface of the alimentary substances; and it must be remarked, that the properties of the chyme differ exceedingly according to the kind of food from which it results. Those herbs which have been triturated and twice masticated by the ruminants give a different stomachic product than animal food, or the grains of the cerealia. It may also be observed, that the digestion of animal substances is more rapid than that of a vegetable diet. Accordingly, the carnivorous animals digest their food more rapidly than the herbivorous; and man, with the plantigrada, which are omnivorous, digest meat more rapidly than leguminous plants or fruits. It often happens with these animals, that vegetable food will traverse the entire intestinal canal, without having lost its natural and distinctive qualities, or being in any way altered, which happens very rarely with animal substances.

The aliment, when softened and digested by the stomach, being now *chyme*, forms a mass nearly homogeneous, and of a different colour in different animals, but usually greyish in our species, and in several others, of a sharp odour and taste, and, from its acidity, turning all vegetable blues into red. In the greater number of mammalia, it is the stomach alone which performs this first part of digestion — the formation of chyme, and the intestines do not proceed to transform the chyme into chyle, until the moment when the stomach has completed this preliminary process. But there are some animals among whom the relative functions of the stomach and intestines are not confined to these definite functions. The horse, for example, which has a very narrow stomach, and yet will eat without intermission for several hours, cannot retain the food in his confined stomach for a sufficient length of time to be completely chymified. Accordingly, the pyloric duct of the horse remains continually open, and the food passes onwards into the intestine without interruption, although not completely chymified; and the process is completed by the intestines, without this confusion of functions being in any way prejudicial to digestion. The time which the food takes to chymify varies much from one animal to another. The mammalia require only a few hours to perform this function, and the same thing happens with the birds of prey; but the serpents and the greater part of the reptiles require entire days and weeks to digest a single meal. The period of time which the same animal takes for digestion is quicker or slower, according as the state of its health is more or less perfect, according as the food is more or less abundant, or is in a greater or less state of minute division; and also, according to the peculiar nature of the substance to be digested. The aliment is finally submitted to the action of the intestinal juices, and the surrounding organs continually maintain a degree of heat, which is always very near to 104° Fahrenheit.

The minute division of the food by mastication is a process indispensable to a rapid digestion. While the teeth and jaws are performing their function, the salivary glands of the mouth continue to secrete a fluid in very considerable quantity. In the ruminantia, and generally in all animals living on a vegetable diet, these salivary glands are very large, while in the carnivorous tribes they are very small.

The entire length of the alimentary canal differs materially among the mammalia. Its length, with the ruminantia, is twenty-seven times that of the body, while it is only from three to five times their length among the carnivora. In omnivorous animals, such as man, its length is intermediate to these, being six or seven times that of the body.

Several experiments have been made by Sir Astley Cooper to ascertain the digestive power of the dog. He found that this animal digested pork more easily than mutton, the latter more rapidly than veal, and beef with greater difficulty than any of the others. He found that fish and cheese were easily digested by the dog, and boiled veal more readily than roast. The fat of meat seemed more digestible than cheese, codfish dissolved more readily than beef, and beef than potato. The order of digestion for the different parts of the same kind of animal food was fat, muscle, skin, cartilage, tendon, and bone, the last being the least digestible. Young dogs, when they have acquired strength, and are in good health, can digest bones; and what is remarkable, Spallanzani has observed that the gastric juice of their stomachs made an impression even upon the enamel of teeth. Boorhaave asserts the contrary, but the observations of Spallanzani have been confirmed. This power of dissolving bone is not peculiar to the mammalia, but is also possessed by some animals of the other classes. Thus the falcons, eagles, and crows, usually refuse bones; but when introduced into their stomachs, with proper precautions, these refractory substances are digested. Serpents and adders also digest them, as has been remarked by Spallanzani. Only the smaller bones, however, possessing the least solidity, are dissolved entirely and rapidly; the harder bones require to be minutely divided in order to be softened and dissolved, otherwise they merely undergo a small loss of substance. It must be observed, that before digesting they pass into a cartilaginous state, and resemble indurated gelatine, as if they had been submitted to the action of nitric acid.

The ruminantia, like the granivorous birds, can digest herbs and grains, only when these substances have been previously divided, mashed, or ground. When entire herbs and solid grains are introduced into their stomachs, whether uncovered, or enclosed in linen, or perforated tubes, these substances undergo no digestion; they are merely moistened or softened, and this is the extent of their modification. The same result is obtained even when they are moistened with saliva. On the contrary, if bags or tubes of mashed herbs or grains be introduced into the stomachs of the ruminants, the digestion is then performed in a few hours. These experiments have been made upon oxen, sheep, and many other ruminantia, and they present similar results for all this order of mammalia. They have also been made upon the horse, and with the same result, although he does not ruminate.

Many physiologists have attempted, with various success, to effect artificial digestions out of the body, by extracting the gastric juices from the stomachs of different animals, and afterwards mixing them with the food. Spallanzani, by these experiments with the gastric juices of different animals, obtained several important results. When cold, the gastric juice produced scarcely any effect; it merely opposed putrefaction, but did not exercise its dissolving and digestive power until it was raised to its proper temperature. It did not act upon grains and herbs until they were ground, mashed, and impregnated with saliva. The gastric juice of man softened and seemed to digest beef in about thirty-six hours, when raised to a temperature equal to that of the stomach. He also observed, that the gastric juice of one species often acted upon a great variety of substances, and yet it did not always act upon substances which could be dissolved by the gastric juice of another species. From these instances of artificial digestion, we may readily expect that the stomach, being lubricated by the gastric juice, will continue to digest after the death of the animal, and even it has been said to digest itself. Hunter first noticed the fact, that the gastric juice will act upon the sides of the stomach after death, and to this cause he attributed the erosions and perforations which are sometimes found in the stomachs of human subjects. Spallanzani made several experiments upon dogs and cats with a similar result. He caused the animals intended for trial to fast for a long time, and then to be fed immediately before being killed. Their bodies were placed in stoves which preserved their natural temperature, and in the course of a few hours he found that the food in their stomachs was sensibly digested. See articles ALIMENT, CHYME, and NUTRITION.

DIGGING. Making excavations or turning up the soil with the spade. Digging, in the latter sense, is the principal process of cultivating all gardens, all allotments, all cottage plots, and whatever pieces of farm-ground are impracticable by the plough. See the article SPADE-HUSBANDRY.

DIGITALIS. See FOXGLOVE.

DIGITARIA,—popularly *Finger-Grass*. A genus of grasses of the panic-grass tribe. The bloody species, *D. sanguinalis*, grows wild in the sandy fields of some parts of Britain, and is of some value, but not much, for its herbage. Its head is divided somewhat in the manner of man's fingers, and used to be thrust up the nostrils by the Germans to cause bleeding at the nose; and hence all its names, generic and specific, botanical and popular. Its root is fibrous; its culms are numerous, jointed, sheathed, first decumbent and next erect, and about a foot high; its leaves are broad, pointed, striated, wavily edged, and, in common with the sheaths, besprinkled with small bristly warts; and its flowers are erect and purplish, grow in pairs, and appear in August. The smooth species, *D. glabra*, is an uninteresting indigenous annual, of about half a foot in height, growing in sandy grounds, and flowering in June and July. About a dozen species, all annuals and more curious than valuable, have been introduced to Britain from various countries of both the old world and the new, and of both temperate latitudes and the tropics; and about 15 additional species are known to exist.

DIKE. A ditch in Cambridgeshire, an embanking mound or dam in some other parts of England, the back of a ditch or sometimes the ditch itself in Ireland, and an uncemented stone wall or stone-enclosure in Scotland. See the articles Ditch, Embankment, and Wall.

DILL,—botanically *Anethum*. A genus of herbaceous plants, of the umbelliferous order. The common or heavy-smelling species, *Anethum graveolens*, is a native of the corn-fields of Spain and Portugal, and was introduced to Britain in 1570; and it is cultivated in our gardens for the uses of both the kitchen and the drug-shop. Its root is long, fusiform, and biennial; its stems are round, striated, erect, jointed, branched, and about a yard high; its leaves have sheathing footstalks, and are doubly pinnated, with linear, pointed, glaucous, fragrant folioles; its flowers grow in large flat umbels on the tops of the branches, are small and yellow, and appear from June till August; and its seeds are brown, oval, concave on the one side, convex and striated on the other, broader, flatter, and rather shorter than the seeds of caraway, and have, when dried, a moderately pungent taste and a sweetish, aromatic, heavy odour. This plant may be sown either thinly broadcast, or in drills of from 6 to 12 inches asunder,—either in spring or in autumn, but with best effect immediately after the seeds are ripe; and it must grow where it is sown, and will not endure any attempt at transplantation. At the end of three or four weeks, all the young plants must be thinned out to distances of about 10 inches. When merely the leaves and umbels are wanted, any open compartment in the garden is suitable; but when ripened seeds are wanted, a sheltered spot with dry warm soil is requisite. The leaves are used for flavouring soups and sauces, the leaves and umbels for flavouring pickles, and the seeds for yielding an essential carminative oil by distillation, for making a carminative water by decoction, and for administration, in the form of powder, to infants for hiccough and flatulent colic.

The fennel species, *Anethum fœniculum*, will be noticed in the article Fennel.—The sowa species, *Anethum sowa*, is cultivated as a medicinal plant in India. It is an annual, has a height of about a foot, and was introduced about 35 years ago to Britain.—The peppery species, *Anethum piperatum*, is cultivated in Italy. It is a biennial, has a height of about two yards, and was introduced to Britain in 1824.—Two other species are known.

DILL. A frequent misnomer, in many parts of England, for the lentil. See the article Lentil.

DILLENIA. A genus of noble, ligneous, tender plants, forming the type of the natural order Dilleniaceæ. This order has a near affinity in botanical character to the magnificent and gorgeous Magnoliaceæ, and even makes a respectable approach to the beauteous grandeur of their appearance. It comprises 12 genera, but has within the gardens and collections of Britain only about 30 species. Most of its plants are natives of the tropics; and some are valuable for either the economical uses of their timber, the medicinal properties of their juices, or the timber-polishing power of their exceedingly scabrous leaves. Nine known species belong to the genus dillenia; but only one of these, *D. speciosa*, exists in Britain. This is a native of India, and was introduced to Britain about 45 years ago. It is an imposing evergreen tree, of about 30 or 35 feet in height; its flowers are large and yellow, and almost rival those of a magnolia; and its timber is used by the Hindoos for various purposes of carpentry. The juice of the fruit of some of the species is agreeably acidulous, and is used in dilution with water as an agreeable drink in fevers.

DILLWYNIA. A genus of ornamental, evergreen, Australian, small shrubs, of the sophora division of the leguminous order. About a dozen species were introduced to Britain during the 25 years preceding 1820; and a number of other species have been introduced at later periods. They have yellow flowers, and present a general resemblance to numerous other yellow-flowered papilionaceous plants; but their flowers are peculiarly lively in tint and profuse in number, and their whole form is pre-eminently handsome and graceful. *Dillwynia glycinifolia*, in particular, is greatly and justly admired by all lovers of New Holland plants; and has such slender branches, such pleasing linear ovate brownish-green leaves, and such a profusion of handsome blossoms, as to produce a better effect in the greenhouse or the conservatory than the majority of other plants of its class.

DILUVIUM. Any geognostic formation or portion of the earth's crust which consists of depositions made, or supposed to have been made, by one or more marine deluges. Many diluvial formations are of great extent, constituting the pavement or subsoil or very deep superficial matter of vast plains; and all differ in a greater or less degree from alluvial formations, in exhibiting traces of marine action, in consisting of larger boulders or grits of rocks, and in containing comparatively little intermixture of organic remains; while not a few differ also in both the vastness of their extent and the greatness of their depth. See the article Alluvium.

Mr. Lyell, however, regards all diluviums as only ancient alluviums, and supposes that they acquired any distinctiveness of character which they possess from upheaving and subsiding changes upon the configuration of the earth's surface. He says: "Before the doctrine of the rising and sinking of large continental areas, whether insensibly or by a repetition of sudden shocks, was admitted as part of the actual course of nature, all ancient alluviums were classed by some authors under the common title of 'diluvium,' and were said not to be due to existing causes. To establish this proposition, it was thought sufficient to demonstrate that the rivers which may now happen to drain a given district, could never, in the course of thousands of ages, have given rise to the valleys of denudation in which they now flow, and that these same rivers could never have washed into their present situations, (often the summits of hills, and high table-lands,) all the gravel and boulders evidently connected with former denuding operations. It was, therefore, usual to refer the 'diluvium' to a deluge, or succession of deluges, which rolled with tremendous violence over the land, after it had acquired its present configuration, and its present height above the sea. Not only small gravel, but large blocks of stone, were supposed to have been transported from a distance by these devastating floods or waves, and lodged upon the hill-tops. But rivers, as we have seen, are not the only existing causes, nor even the most energetic agents, by which denudation may be effected. If the upward movement of land be very slow, the waves may clear away a stratum of yielding materials as fast as they rise, and before they reach the surface. Thus, a wide uninterrupted expanse of denudation may take place, and masses, many hundreds of feet or yards in thickness, may waste away by inches in the course of thousands of centuries. But if reefs composed of a more refractory stone should at length rise up, the breakers, as they foam over them, may still tear off fragments, and roll them along until the bottom of the sea becomes strewed over with blocks and pebbles. This alluvium of marine origin will be uplifted when the reefs are ultimately converted into land, and may then constitute the covering of the summits of hills, or of elevated terraces or table-lands. At the same time, this gravel may be wanting in all valleys excavated either during the rise of the land, by currents of the sea running between islands, or eaten out or deepened by rivers after the emergence of the land. At the bottom of such more modern valleys, a distinct alluvium will be found, containing, perhaps, some pebbles washed out of the older or upland gravel, but principally composed of the ruins of rocks removed during the erosion of the newer valleys."

Yet, for practical purposes, neither the theory nor the designation of the deposits in question is of much consequence. Lands consisting of these deposits, whether called diluvial or old and marine alluvial, are, in a general view, far inferior in value to lands which consist of either fluviatile or lacustrine alluvium; and since they unquestionably possess a distinctive character, they ought, for the convenience of scientific farmers, to bear a distinctive name. The diluvium of mountains and hills is a main origin of the alluvium of valleys; and the diluvium of a considerable proportion of plains is so far covered with alluvium as to sustain the relation to it of subsoil. The diluvial character of the land upon an uniformly exposed range of hills, but especially the diluvial character of a great plain, whether that character refer chiefly to the soil or chiefly to the subsoil, affords great facility to the estimating of the value of fields and farms, enabling any person acquainted with the agricultural properties of any one portion of it to form a ready and fair opinion of the probable comparative fertility of any other portion. By far the most interesting diluvial district of the United Kingdom is the vast flœtz limestone plain of Ireland,—that singularly great and uniformly fertile region which has won for Erin the fond name of "the emerald isle," and which has thoroughly resisted a degree of general maltreatment which, if perpetrated upon them, would long ago have utterly desolated some of the best districts of Great Britain.

DINEBRA. A small genus of grasses, of the chloris tribe. The Arabian species, *D. arabica*, is a native of various warm countries, and was introduced to Britain from India about 40 years ago. It is a curious annual of 6 or 8 inches in height, and naturally flowers about midsummer. Four or five other species have been botanically described.

DINGLE. A prolonged depression between two hills or mountains. It differs from a broad glen or small valley in not being traversed, and in not having been geognostically formed, by a water-course.

DIŒCIOUS PLANTS. All vegetable species whose male or stameniferous flowers grow on one set of plants, and their female or pistiliferous flowers on another set. Each species has its flowers, as it were, "in two houses,"—a phrase which is almost a literal translation of "diœcious." These plants constitute the 22d class of the Linnæan system, and are subdivided into thirteen orders, with respectively one, two, three, four, five, six, eight, nine, ten, twelve, between twelve and twenty, upwards of twenty, and monadelphic stamens; and they comprise within the open grounds and the gardens of Great Britain upwards of 100 genera, and between 700 and 800 species.

DIOSCOREA. See YAM.

DIOSMA. A genus of beautiful, fragrant, greenhouse, Cape-of-Good-Hope, evergreen undershrubs and small shrubs, of the rue order. One of the earliest known species is described in the following brief and popular terms by Miller, and may serve as a specimen of the whole genus: "It rises to the height of 3 feet; the branches are very long and slender, and are produced from the stem very irregularly; the leaves are placed crossways, and are pointed,—these are every evening closed up to the branches; the flowers are produced along the branches from between the leaves,—and in the evening, when these flowers are expanded, and the leaves are closely embracing the stalks, the whole plant appears as if covered with spikes of white flowers." The name diosma signifies "divine smell," and alludes to a very grateful fragrance which arises from the whole plant of a diosma, but especially from a resinous matter in the seeds, and which occasioned the genus to be long known by the popular name of Sweet African Spiræa. A number of plants which were formerly ranked as diosmas are now distributed among seven other genera; but between 20 and 30 species still ranked as diosmas exist in British gardens, and nearly 20 additional species are known to botanists. One of the most valuable of the species is the subject of our article BUCHU. The diosma genus is the type of a large suborder of Rutaceæ; and this suborder comprises 23 genera, and is subdivided into European diosmeæ, Cape diosmeæ, Australian diosmeæ, and American diosmeæ.

DIOSPYROS. See DATE-PLUM.

DIOTIS. A genus of plants, of the goosefoot order. The atriplexine species, *D. atriplicina*, called by some botanists *Atriplex pedunculata*, is an annual weed of the fields of Britain, about a foot in height, and usually flowering in June and July. The horn-like species, *D. ceratoides*, is a deciduous undershrub of Siberia, introduced to Britain about 75 years ago, and flowering early in spring.

DIPLACHNE. A small genus of grasses of the fescue tribe. The bundled species, *Diplachne fascicularis*, called by Michaux *Festuca polystachya*, is a hardy annual, of about two feet in height, but of small agricultural value, introduced about 24 years ago from North America.

DIPLACUS. A genus of ornamental plants, of the figwort tribe. The scarlet-flowered species, *D. puniceus*, was introduced to Britain from California in the autumn of 1837, and has proved a most imposing accession to the ornaments of our greenhouses. It is an evergreen shrub of very bushy habit, and of naturally 5 or 6 feet high, and constitutes a gorgeous feature of the close landscapes of its natural country; and it suits well for dwarfed growth upon the stands of our conservatories. Its flowers have the same rich shade of colour as those of *Mimulus glutinosus*, but are far more brilliant; and young plants of it, contrary to the usual law of phænogams, bloom far more freely, and have larger flowers, than old plants.

DIPSACUS. See TEASEL.

DIRCA. A hardy, deciduous, economical shrub, of the wild olive order. It constitutes a genus of itself, and takes for its specific name *palustris*. It is a native of marshy woods in various parts of North America, and particularly in Virginia, and was introduced to Britain about the middle of last century. It usually attains a height of from 4 to 6 feet, and has the habit and outline of a small tree. Its twigs are remarkable for toughness, and are as strong and pliable as those of the lime-tree, and are employed in America for the manufacture of various small articles; its bark also has a homogeneous character with the twigs, and is used for making ropes and baskets; and both, but especially the twigs, occasion the plant to be popularly called in Canada leather-wood. Its flowers are small, yellow, and inconspicuous, and appear in March and April; and the pale green scales of its buds surround the flowers, and seem to perform for a time the functions of leaves. This plant is an excessive favourite with snails; and, on that account, continues to be sparingly propagated in Britain.

DIRECT TAX. Taxes are distinguished into *direct* and *indirect*. A tax is direct when it is paid by the persons who permanently own, or use, or consume the subject of the tax. An indirect tax falls ultimately on a different person from the one who immediately pays it to the government. Thus the importer of goods pays a duty on them to the government, but reimburses himself by charging the amount of this duty in the price of the goods, so that the retailer who takes them of him refunds the duty, and the consumer who takes them of the retailer again reimburses the latter. On the contrary, a land-tax, a capitation-tax, an annual excise on watches, coaches, &c., or an excise collected on articles as they are distributed by the retail dealer among his customers for consumption, is a direct tax; for the party really taxed is the one who pays the tax to the government.

DISA. A genus of Cape-of-Good-Hope epiphytous plants, of the orchis order. About a dozen species were introduced to Britain during the 20 years following 1804; and twice as many more have been botanically described. Several of the species, particularly the large-flowered, with a prevailing scarlet colour, the grass-leaved, with a prevailing blue colour, and the horned, with a predominating pale blue colour, are exceedingly beautiful and imposing; and they possess the recommendation of not being so tender as most of the other first-rate orchideous beauties.

DISBUDDING. The removing of some of the buds, in order to concentrate the sap in the remaining buds, of vines, wall-trees, and other fruiting plants. Even the disbudding of shoots with the leaves on is recommended by Mr. Roberts in his work on the Vine, and by Mr. Ayres in a communication in the Gardener's Chronicle. "While the leaves are yet green," says the latter, "the shoots or spurs are divested of such buds as are not intended to produce fruit the following season. The result of this is, that the organizable matter prepared by 50 or 100 leaves is concentrated in 20 or 30 buds, instead of being divided among three or four times that number, as it is by the general system of management. Though this is merely an extended application of the principle of the concentration of the sap practised in disbudding and various allied operations, yet it is one of immense importance when applied to the vine and to the shoots of ligneous plants with the leaves on. The buds, in consequence of having so much sap concentrated in them, become highly excitable, and, with the slightest application of heat in early spring, they push with the greatest vigour. There may, under certain circumstances, be a fear of the premature bursting of the buds; but this, in general, may be prevented by leaving two or three small laterals on the most vertical part of the vine."

DISCOUNT. An allowance made on a bill, or any other debt not yet become due, in consideration of present payment. Bankers, merchants, &c., allow for discount a sum equal to the interest of the bill for the time before it becomes due, which, however, is not just; for, as the true value of the discount is equal to the difference between the debt and its present worth, it is equal only to the interest of that present worth, instead of the interest on the whole debt. And, therefore, the rule for finding the true discount is this: As the amount of £1 and interest for the given rate and time is to the given sum or debt, so is the interest of £1 for the given rate and time to the discount of the debt. Thus, if the interest or discount of money were five per cent., then the allowance on a bill of £100 would be found thus: As 21s. : £100 : : 1s. : £4 15s. $2\frac{18}{21}$d.

DISEASES OF ANIMALS. Deranged conditions of some of the organs of animals, or vitiated conditions of their blood, or their secretions. Some can be traced to very obvious causes; and many are exceedingly obscure in origin; yet most are known to arise either wholly or chiefly from the effects of improper food and bad air. If farmers used due care that all the food of their animals were sound and seasonable, that their cattle houses were well ventilated, and that no pond or fen should exist to create miasmata, they would lose comparatively few of their stock, except from accidents and old age. The principal diseases of horses, cattle, and sheep, form the subjects of part or whole of our articles Abortion, Staggers, Bleeding, Inflammation, Blindness, Cancer, Catarrh, Consumption, Costiveness, Cough, Diarrhœa, Dysentery, Diabetes, Fever, Braxy, Foul, Garget, Hoose, Hoove, Hydatid, Hydrophobia, Indigestion, Influenza, Jaundice, Mange, Quinsy, Black-Water, Red-Water, Rheumatism, Rot, Scab, Yellows, Abscess, Broken-Wind, Colic, Farcy, Gangrene, Glanders, Dropsy, Locked-Jaw, Poll-Evil, Quittor, Spavin, Bone-Spavin, Thrush, and Worms.

DISEASES OF PLANTS Vitiated conditions of the juices of plants, or derangement, rupture, or inaction of some of their organs. Some of the chief diseases of plants form the subject of our articles Blight, Mildew, Smut, Ergot, Dropsy, Gangrene, and Honey-Dew; and others are noticed in our articles on the various insects and fungi which cause them.

DISINTEGRATION. See Alluvium, Alkalies, and Soils.

DISLOCATION. The displacing of the articular surface of the bones of living animals from their proper situation. The reducing of dislocations is an important department in human surgery; but, in consequence of the very powerful resistance offered to it, and of the imperfect state of mechanical means for overcoming this, the reducing of dislocations is very seldom attempted in veterinary practice.

DISOCACTUS. An interesting and recently discovered genus of plants, of the cactus tribe. The two-shaped species, *D. biformis*, was sent to Britain from Honduras in 1839. Its stems are round, quill-like, and about a yard high; its branches are flattened and fleshy; its flowers have a deep pink colour, and are produced solitarily at the extremities of the branches; and its fruit or berries are crimson-coloured, egg-shaped, and rather smaller than sloes, with smooth, glossy, and transparent skin, and with a soft, mucilaginous, sweetish, and slightly acidulous pulp,—both the skin and the pulp crimson-coloured, but the latter of a lighter shade than the former. This plant is of very easy culture, and seems to set its fruit more readily than any other species of cactus; so that, for the purpose of affording an occasional and rare show of its crimson berries, it may probably come into general and high request. The period of its fruiting, too, is quite as beautiful as the period of its rich and imposing bloom.

DISPERSION OF SEEDS. See Seeds.

DISSECTION. The scientific and systematic cutting up of a carcase, a plant, or a seed, with the view of examining its organic structure. The dissection of seeds is a very nice and delicate operation, yet has been so judiciously and successfully conducted, particularly by Gærtner, as to throw great light upon the science of phytology, and the practices of culture.

DISTEMPER. Any prevailing disease either among crops or among farm-stock. The diseases most frequently called distemper among crops are mildew, smut, and ergot; and those most freqently called distemper among cattle and horses are catarrh, dysentery, and epizootic fever.

DISTILLATION. An art founded upon the different tendencies which bodies have to pass into vapour, and to be condensed again by cold, and is performed in order to separate them from each other, when combined, or when they become products of chemical action. Its use is very important in obtaining spirits, essences, volatile oils, &c. The most common method of conducting this process consists in placing the liquid to be distilled in a vessel called a *still*, made of copper, having a moveable head, with a swan-like neck, which is so formed as to fit a coiled tube, packed away in a tub of water constantly kept cold, and which is termed a *refrigeratory*. The fire is applied either immediately to the still, or mediately, by means of a water or sand bath. The liquid to be obtained rises, in vapour, into the head of the still, and, passing down the curved tube, or worm, becomes condensed, and makes its exit in a liquid state. The still should be constructed with a diameter considerably greater than its height, in order to expose a larger surface to the fire; and the tube should not be so narrow as to impede the passage of the vapour into the worm.

An improvement by Mr. Tennant in this apparatus, consists in introducing the spiral tube into the body of a second still, so that the heat from the condensation of the steam, passing through the tube, is applied to the distillation of liquor in the second. The pressure of the atmosphere is removed from the latter, by connecting it with an air-tight receiver, kept cool. The air in this receiver is allowed to escape at the commencement of the operation; its place is occupied by the steam from the liquor, which being condensed, a vacuum is kept up, whence the distillation proceeds, without any further heat being directly applied to the second still. This form of distilling apparatus is called the *double still.*

The process introduced by Mr. Barry, for preparing vegetable extracts and inspissated juices, by evaporation *in vacuo*, is of a somewhat similar nature. The apparatus consists of a hemispherical still, made of cast-iron, and polished within. It is closed by an air-tight flat cover, through which rises a wide tube, which is then bent downwards, and terminates in a large copper globe, of a capacity three or four times greater than that of the still. In this tube there is a stop-cock, between the still and the globe. When evaporation is to be performed, the vegetable juice or infusion is poured into the polished iron still, through an opening, which is then closed, made air-tight, and covered with water. In order to produce a vacuum, the connexion between the still and copper receiver is interrupted, by shutting the stop-cock, and steam from a boiler is introduced by a pipe into the latter, till the whole of the air is expelled from it. This takes usually about five minutes, and is known by the steam issuing from the globe uncondensed. The copper sphere is then closed, and the communication restored between it and the still, by opening the stop-cock, when the greater part of the air in the latter rushes into the former. The stop-cock is again closed, and the globe again filled with steam as before. By the condensation of this steam a vacuum is again produced, which, on opening the stop-cock, extracts the greater portion of the air remaining in the still: in short, by repeating these exhaustions five or six times, an almost perfect vacuum is obtained, both in the still and receiver. Heat is then applied to the water bath, in which the still is placed, until the juice within begins to boil, which is ascertained by inspection through a piece of thick glass, fixed firmly in the upper part of the apparatus. As, in a vacuum, fluids boil nearly 124 degrees below their usual boiling temperature, water passes into ebullition, in such circumstances, at 90° Fahr., or a little above it; and it is never found necessary to heat the juice above a temperature of 100°. The evaporation is continued till the fluid is inspissated to the proper extent, which is judged of by its appearance through the glass. Extracts prepared in this way are found to be greatly preferable to those obtained by evaporation at a high temperature: they are considerably stronger, as the active principles in the juices are not decomposed by reaction between their elements, favoured by heat; and they are free from all burnt flavour, or empyreuma.

There are many operations, however, in which liquids are employed, that would corrode metallic vessels: in such cases, vessels are employed, constructed either of glass, platinum, or stone ware. They are of various forms, generally consisting of two parts, one called a *retort*, and the other a *receiver.* The receiver is sometimes tubulated, with a stopper adapted to the tubulature. In some cases of distillation, the product is not entirely a vapour which may be condensed; but there is disengaged an elastic fluid, which is incondensable. This gas is allowed to pass off by a tube from the tubulature; the tube terminating in a vessel of water, and thus enabling us to collect the gas in an inverted jar. In certain cases, the product designed to be obtained by distillation is an elastic fluid, not condensable by itself, but capable of being condensed by being transmitted through water. A contrivance called *Wolfe's apparatus* is used for this purpose, a description of which may be found in most of the chemical treatises. A liquid obtained by distillation is sometimes not perfectly pure, or it is dilute, from the intermixture of water, that has been elevated in vapour along with it. By repeating the distillation of it a second or a third time, it is rendered more pure and strong. This latter process is named *rectification,* or sometimes *concentration.*

DISTRESS. In law, the taking of a personal chattel of a wrong-doer, or a tenant, in order to obtain satisfaction for the wrong done, or for rent or service due. The thing taken is also called a *distress.* A distress may be taken for homage, fealty, or any other service, of which there were many descriptions under the old feudal tenures, due from the tenant to the lord, or person of whom the estate was holden, the rendering or payment of which was the consideration or condition on which the land was held. So a distress is, by the English and American law, allowed to be made of cattle or goods *damage-feasant,* both for the purpose of preventing further damage, and obtaining satisfaction for that already done. If the party whose goods or cattle are seized, disputes the injury, service, duty, or rent, on account of which the distress is taken, he may replevy the things taken, giving bonds, at the same time, to return them or pay damage, in case the party making the distress shows that the wrong has been done, or the service or rent is due, on account of which the distress was taken. Another description of distress is that of attachment to compel a party to appear before a court when summoned for this purpose. The distresses most frequently made are on account of *damage-feasance* and rent; though the ordinary attachments on mesne process, that is, on a writ before judgment, that the judgment may be satisfied out of the property so seized, coincides in principle with the right of distress. The reason for giving a right of distress in cases of damage-feasance is obvious, but it is by no means so evident why a landlord should have a right to distrain for his rent, any more than a grocer for a debt accruing on account of articles supplied for the use of his debtor's family. As to the things that may be distrained, the English law allows any chattel of the lessee, on the premises, to be so taken. The law also prescribes particularly the time and mode of making the distress, and the manner of treating the things, especially beasts, distrained.

DITCH. A trench cut along the division-lines of cultivated grounds, to serve either as a drain or as a fence. Most ditches in old husbandry were intended solely as open drains, and many in the moor improvements of the present day possess the same character; but nearly all ditches in modern arable farm-lands are designed to serve also and even chiefly as enclosures, and most of them are combined with a hedge, a bank, or some other form of fence. Ditches are of very various depths and widths; some are as wide at the bottom as at the top, some slope gradually on both sides from the top to the bottom, and some have one side sloping and the other side perpendicular; and such as slope vary exceedingly from one another in the degrees of their inclination. Whenever a ditch has considerable depth, or is cut in inadhesive strata, or is designed wholly or principally for drainage, it ought to slope on both sides, and to have a width at top of from three to six times more than at bottom. One kind of fence common in many districts consists of a sloping ditch and a bank of earth,—the latter formed of the earth thrown out of the former; another, which is common in many cold, clayey lands of England, consists of two ditches and a hedge between them; and another, but not a common one, consists of two ditches and a bank between them,—the bank usually surmounted by a strong hedge or by a line of trees. See the article Hedge.

All sorts of ditches, but especially such as have a considerable quantity of water, either flowing or partially stagnant, are liable to be speedily choked up with rank vegetation, and require to be periodically scoured and constantly kept open and clean. Among the most common of the plants which grow in them, and are liable to choke them up, are *Poa aquatica*, *Poa fluitans*, *Tussilago petasites*, *Rumex crispus*, *Degraphis arundinacea*, *Iris pseudacoris*, *Nasturtium officinale*, *Veronica beccabunga*, and *Polygonum amphibium;* and any of these, or of several others, can be restrained within innocuous limits only by periodically paring the sides and scouring the bottom of the ditches with the spade, while the last, *Polygonum amphibium*, can be even tolerably subdued by no less severe a process than the careful extermination of every vestige of it which can be discovered. The scouring of all ditches ought to be as distinctly a part of the routine or regular business of a farm as the tilling of the ground or the managing of the crops; and, in the case of all hedge-ditches, it ought always to accompany the dressing of the hedges. The accumulated mass of mixed earth and vegetable matters obtained by the scourings, yields valuable manure, whether by being incinerated, or by being heaped up and turned till all stems, roots, and seeds have been thoroughly killed by begun decomposition. See the articles Ashes and Compost.

DIURETIC. Any substance which stimulates the kidneys of an animal to secrete an unusually large quantity of urine. Diuretics operate more easily and powerfully upon the horse than upon man; and require, in veterinary practice, to be used with much judgment and considerable caution. Unsuspected diuretics, such as foxy oats, mow-burnt hay, and certain ingredients in the natural herbage of particular localities, often produce slow and steady derangement of the urinary organs, by frequent, daily, or constant over-stimulation, till the kidneys become inflamed or some other organ severely injured; and medicinal diuretics intentionally administered may, by overdosing or by too prolonged use, either produce some chronic disease in the urinary organs or excite violent and fatal inflammation. Yet diuretics wisely used, are of eminent service in cracks, swelled legs, mild grease, dropsical affections, and all other conditions of the system which require a diminished secretion of the watery elements of the blood; and when given in moderate doses to a horse, they do not require the animal to be shut up in the house, but leave him at full liberty to perform his ordinary work upon the farm. One of the cheapest and most useful diuretics for all ordinary uses, is common oil of turpentine; two of the best, to be combined with it in a feverish state of the system, are foxglove and saltpetre; and two good but expensive ones, which possess no high virtue to correspond with their high price, are camphor and castile soap. Minor diuretics, both in medicine and in food, are very numerous.

DIURIS. A genus of Australian plants, of the orchis tribe. The name signifies 'a double tail,' and alludes to the lobes of the column. The golden species, *D. aurea*, introduced to Britain about 35 years ago, and producing flowers of a predominantly golden colour, has a superb appearance, and possesses the recommendation of being comparatively hardy and unfastidious. Six curious tuberous-rooted species were introduced about 10 or 15 years after the golden species.

DIVIDIVI. See Cæsalpinia.

DIVING-BELL. To illustrate the principle of this machine, take a glass tumbler, plunge it into water with the mouth perpendicularly downwards; you will find that very little water will rise into the tumbler, which will be evident if you lay a piece of cork upon the surface of the water, and put the tumbler over it; for you will see, that, though the cork should be carried far below the surface of the water, yet its upper side is not wetted, the air which was in the tumbler having prevented the entrance of the water; but, as the air is compressible, it could not entirely exclude the water, which, by its pressure, condensed the air a little.—The first diving-bell we read of in Europe was tried at Cadiz, by two Greeks, in the presence of Charles V. and 10,000 spectators. It resembled a large kettle inverted. The first of any note was made by Dr. Halley. It is most commonly made in the form of a truncated cone, the smallest end being closed, and the larger one open. It is so suspended that it may sink full of air, with its open base downwards, and as near as may be parallel to the horizon, so as to close with the surface of the water. Mr. Smeaton's diving-bell, made in 1788, was a square chest of cast-iron, 4½ feet in height, 4½ feet in length, and 3 feet wide, and afforded room for two men to work in it. It was supplied with fresh air by a forcing pump. This was used with great success at Ramsgate. Other contrivances have been used for diving-bells. Within the last 30 years, the diving-bell has been much employed to assist in laying the foundations of buildings under water. A diving-bell, on an improved principle, was constructed, in 1812, by the late Mr. Rennie, and employed in Ramsgate harbour, where it answered so well, that the masonry was laid with the utmost precision. From this period must be dated a new era in the construction of masonry under water, the use of coffer dams being, in a considerable degree, superseded. The diving-bell was, thenceforward, employed by Mr. Rennie in the construction of all the great harbours which he projected. Round bells of cast-iron and copper have been occasionally made for the pearl and coral fisheries of South America, and have been supplied by the Messrs. Rennie for most of the royal dock-yards in England, and several of those in the colonies, for the pearl fishery at Ceylon, for the repair of the works at Cronstadt, for many places in Great Britain and Ireland, &c.

DIVINING ROD. A rod made with certain superstitious ceremonies, either single and curved, or with two branches, like a fork, of wood, brass, or other metal. The rod is held in a particular way, and if it bends towards one side, those who use the rod believe it to be an indication that there is treasure under the spot. Some publications respecting a man who, in quite recent times, pretended to be able to discover water and metals under the ground by his feelings, attracted much attention.

DIVISIBILITY. The actual subdivision of bodies has, in many cases, been carried to a prodigious extent. A slip of ivory, of an inch in length, is frequently divided into a hundred equal parts, which are distinctly visible. But, by the application of a very fine screw, 5,000 equidistant lines, in the space of a quarter of an inch, can be traced on a surface of steel or glass with the fine point of a diamond, producing delicate iridescent colours. Common writing paper has a thickness of about the 500th part of an inch; but the pellicle separated from ox-gut, and then doubled to form gold-beaters' skin, is six times thinner. A single pound of cotton has been spun into a thread 76 miles in length; and the same quantity of wool has been extended into a thread of 95 miles; the diameters of those threads being hence only the 350th and 400th parts of an inch. But the ductility of some metals far exceeds that of any other substance. The gold-beaters begin with a riband an inch broad and 150 inches long, which has been reduced, by passing through rollers, to about the 800th part of an inch in thickness. This riband is cut into squares, which are disposed between leaves of vellum, and beat by a heavy hammer, till they acquire a breadth of more than three inches, and are therefore extended ten times. These are again quartered, and placed between the folds of gold-beaters' skin, and stretched out, by the operation of a lighter hammer, to the breadth of five inches. The same process is repeated, sometimes more than once, by a succession of lighter hammers; so that 376 grains of gold are thus finally extended into 2,000 leaves of 3·3 inches square, making in all 80 books, containing each 25 leaves. The metal is, consequently, reduced to the thinness of the 282,000th part of an inch, and every leaf weighs rather less than the 5th part of a grain. Silver is likewise capable of being laminated, but will scarcely bear an extension above half that of gold, or the 150,000th part of an inch thick. Copper and tin have still inferior degrees of ductility, and cannot, perhaps, be beat thinner than the 20,000th part of an inch. These form what is called *Dutch leaf*. In the gilding of buttons, five grains of gold, which is applied as an amalgam with mercury, is allowed to each gross; so that the coating left must amount to the 110,000th part of an inch in thickness. If a piece of ivory or white satin be immersed in a nitro-muriate solution of gold, and then plunged into a jar of hydrogen gas, it will become covered with a surface of gold hardly exceeding in thickness the 10,000,000th part of an inch. The gilt wire used in embroidery is formed by extending gold over a surface of silver. A silver rod, about two feet long and an inch and a half in diameter, and therefore weighing nearly 20 pounds, is richly coated with about 800 grains of pure gold. In England, the lowest proportion allowed is 100 grains of gold to a pound of silver. This gilt rod is then drawn through a series of diminishing holes, till it has stretched to the vast length of 240 miles, when the gold has, consequently, become attenuated 800 times, each grain covering a surface of 9,600 square inches. This wire being now flatted, the golden film suffers a further extension, and has its thickness reduced to the four or five millionth part of an inch. It has been asserted, that wires of pure gold can be drawn of only the 4,000th part of an inch in diameter. But Doctor W. H. Wollaston, by an ingenious process, has lately advanced much further. Taking a short cylinder of silver, about the third part of an inch in diameter, he drilled a fine hole through its axis, and inserted a wire of platinum, only the 100th part of an inch thick. This silver mould was now drawn through the successive holes of a steel plate, till its diameter was brought to near the 1,500th part of an inch, and, consequently, the internal wire, being diminished in the same proportion, was reduced to between the four and five thousandth part of an inch. The compound wire was then dipped in warm nitric acid, which dissolved the silver, and left its core, or the wire of platinum. By passing the incrusted platinum through a greater number of holes, wires still finer were obtained, some of them only the 30,000th part of an inch in diameter. The tenacity of the metal, before reaching that limit, was considerable; a platinum wire of the 18,000th part of an inch in diameter, supporting the weight of one grain and a third. Such excessive fineness is hardly surpassed by the filamentous productions of nature. Human hair varies in thickness, from the 250th to the 600th part of an inch. The fibre of the coarsest wool is about the 500th part of an inch in diameter, and that of the finest only the 1,500th part. The silk line, as spun by the worm, is about the 5,000th part of an inch thick; but a spider's line is, perhaps, six times finer, or only the 30,000th part of an inch in diameter: insomuch, that a single pound of this attenuated substance might be sufficient to encompass our globe. The red globules of the human blood have an irregular, roundish shape, from the 2,500th to the 3,300th of an inch in diameter, with a dark central spot.

The trituration and levigation of powders, and the perennial abrasion and waste of the surface of solid bodies, occasion a disintegration of particles, almost exceeding the powers of computation. Emery, after it has been ground, is thrown into a vat filled with water, and the fineness of the powder is distinguished by the time of its subsidence. In very dry situations, the dust lodged near the corners and crevices of ancient buildings is, by the continual agitation of the air, made to give a glossy polish to the interior side of the pillars, and the less prominent parts of those venerable remains. So fine is the sand on the adust plains of Arabia, that it is carried sometimes 300 miles over the Mediterranean, by the sweeping sirocco. Along the shores of that sea, the rocks are peopled by the pholas, a testaceous and edible worm, which, though very soft, yet, by unwearied perseverance, works a cylindrical hole into the heart of the hardest stone. The marble steps of the great churches in Italy are worn by the incessant crawling of abject devotees; nay, the hands and feet of bronze statues are, in the lapse of ages, wasted away by the ardent kisses of innumerable pilgrims that resort to those shrines. What an evanescent pelicle of the metal must be abraded at each successive contact! The solutions of certain saline bodies, and of other coloured substances, exhibit a prodigious subdivision and dissemination of matter. A single grain of the sulphate of copper, or blue vitriol, will communicate a fine azure tint to five gallons of water. In this case, the copper must be attenuated at least ten million times; yet each drop of the liquid may contain as many coloured particles, distinguishable by our unassisted vision. A still minuter portion of cochineal, dissolved in deliquiate potash, will strike a bright purple colour through an equal mass of water.

Odours are capable of a much wider diffusion. A single grain of musk has been known to perfume a large room for the space of 20 years. Consider how often, during that time, the air of the apartment must have been renewed, and have become charged with fresh odour! At the lowest computation, the musk had been subdivided into 320 quadrillions of particles, each of them capable of affecting the olfactory organs. The vast diffusion of odorous effluvia may be conceived from the fact, that a lump of assafœtida, exposed to the open air, lost only a grain in seven weeks. Yet, since dogs hunt by the scent alone, the effluvia emitted from the several species of animals, and from different individuals of the same race, must be essentially distinct. The vapour of pestilence conveys its poison in a still more subtile and attenuated form. The seeds of contagion are known to lurk, for years, in various absorbent substances, which scatter death on exposure to the air. But the diffusion of the particles of light defies all powers of calculation. A small taper will, in a twinkling illuminate the atmosphere to the distance of four miles; yet the luminous particles which fill that wide concavity cannot amount to the 5,000th part of a grain, which may be the whole consumption of the wax in light, smoke and ashes.

Animated matter likewise exhibits, in many instances, a wonderful subdivision. The milt of a codfish, when it begins to putrefy, has been computed to contain a billion of perfect insects; so that thousands of these living creatures could be lifted on the point of a needle. But the infusory animalcules display, in their structure and functions, the most transcendent attenuation of matter. The *vibrio undula*, found in duck-weed, is computed to be ten thousand million times smaller than a hemp seed. The *vibrio lineola* occurs in vegetable infusions, every drop containing myriads of those oblong points. Of the *monas gelatinosa*, discovered in ditch water, millions appear in the field of a microscope, playing, like the sunbeams, in a single drop of liquid. Insects have been discovered so small as not to exceed the 10,000th part of an inch, so that 1,000,000,000,000 of them might be contained within the space of one cubic inch; yet each animalcule must consist of parts connected with each other, with vessels, with fluids, and with organs necessary for its motions, for its increase, for its propagation, &c. How inconceivably small must those organs be! and yet they are, unquestionably, composed of other parts still smaller, and still farther removed from the perception of our senses.

DOCK,—botanically *Rumex*. A large genus of green-flowered plants, principally hardy and herbaceous, of the polygonum order. Eleven species are indigenous, and aggregately figure as one of the bulkiest and best known of our weeds; about 60 species have been introduced, principally to botanic gardens and curious collections, from various countries of Europe, Africa, Australasia, and America; and about 30 other species are known to botanists. Most of our indigenous species are more or less medicinal; one of the introduced species is culinary; one of the indigenous species is cultivated for salad; and several fusiform-rooted, large-leaved, indigenous species give great annoyance to farmers, and always indicate by their presence the want of due care and labour in husbandry.

The water dock, *Rumex aquaticus*, or *Rumex hydrolapathum*, grows wild in our ditches and on the banks of our rivers. Its root is fusiform and thick; its stem is erect, furrowed, smooth, and about 5 feet high; its upper leaves are lanceolate, pointed, and almost glaucous; and its flowers are approximately whorled and nodding, and appear in July and August. The root of this species is powerfully astringent, and has a very austere taste, and was formerly cultivated, under the name of *Herba Britannica*, as a remedy for scurvy and for other diseases of the skin.—The broad-leaved or common dock, *Rumex obtusifolius*, is exceedingly common on grassy pastures, by the way-sides, and on small waste or neglected pieces of rich soil, and is the dock *par excellence* of the English, and the docken of the Scotch. Its root is fusiform, large, externally black, and internally yellowish; its stem is usually about a yard high; its leaves have a diversity of form and size, but in general are rounded at their extremity, and about 10 or 11 inches in length, and 5 inches in maximum breadth; and its flowers grow in whorls sitting close to the stems, and appear from June till August. This plant, wherever it appears on a farm, ought to be kept down and exterminated by constant stubbing and eradication, and ought never to be allowed to grow to seed. A decoction of its root is highly efficacious in obstinate cases of the kind of skin-disease called ichthyosis; and when taken in large quantity—as well indeed as the decoction of almost any of the fusiform dock-roots—it acts as a purgative in the same manner as the powder or the tincture of Turkey rhubarb.

The sorrel dock, *Rumex acetosa*, the sheep's-sorrel dock, *Rumex acetosella*, and the French sorrel dock, *Rumex scutatus*, the first and the second indigenous, and the last introduced from France, will be noticed in the article Sorrel.—The bloody dock, or bloodwort, *Rumex sanguineus*, grows wild in shady situations in many parts of England, and is sometimes cultivated in gardens for its curiously ornamental appearance. Its roots are fusiform; its stems are stiff, branching, reddish, and about a yard high; its leaves are heart-shaped at the base, tapering toward the top, long, narrow, and either all of a deep blood-red colour or of a deep green base with blood-red veins; and its flowers grow in terminal clusters, are small and numerous, and appear in July. The root of this species, besides possessing properties similar to those of the roots of the common and the water dock, is supposed to be remedial for the spitting of blood.

The curled dock, *Rumex crispus*, abounds in pastures, ditches, waste grounds, heaps of rubbish, and road-sides in most parts of Britain, and is very unprofitable and troublesome, and requires to be kept down in the same manner as the common dock. Its root is fusiform; its stem is yellowish, somewhat zigzag, and about 2 or 2½ feet high; its leaves are smooth and lightish-green; and its flowers grow in clusters of crowded whorls or tufts, and appear in June and July.—The sharp dock, *Rumex acutus*, is not uncommon in low meadows and watery places of Britain; and has been found of some use to dyers. Its root is fusiform, blackish, and rather slender; its stem is about two feet high; its leaves are sharp-pointed; and its flowers appear in June and July.—The fair or pretty dock, *Rumex pulcher*, grows wild in the gravelly pastures of Britain, has a height of about two feet, and flowers from June till August.—The marsh dock, *Rumex palustris*, grows wild in some of the marshes of England, has a height of about two feet, and flowers in July and August.—The sea dock, *Rumex maritimus*, grows wild in some salt marshes of both England and Scotland, has a height of about a foot, and flowers in July and August.—All the British species, except the sorrels, have fusiform roots.—The only other species particularly worth noticing will form the subject of the brief article Patience.

DOCKEN. See Dock.

DOCKING. The amputation of the greater part of the tail of any domestic quadruped, but particularly of the horse. This practice has been advocated for the three reasons of throwing into the rest of the system the portion of blood which would otherwise be expended upon the amputated tail,—of improving the appearance of the animal,—and of promoting the convenience and comfort of the riders or drivers of horses; but the first of these reasons is imaginary and absurd, the second is a matter of vitiated taste, and the third is, in a considerable degree, a misnomer for mere fashion and caprice. All right feeling and all good taste revolt from the cruelty of inflicting upon an animal the violent pain of amputation, and of, at the same time, depriving him of the means of defence with which the beneficent Creator has provided him against thousands of torturing attacks from insects. See how incessantly cattle ply their tails during the heat of a summer's day; and imagine what would be their sufferings if they had no tails to ply! Yet so long as blind custom and a reckless regard to a little convenience in man insist on the docking of the horse, let the operation be performed with as little cruelty as possible to its victim. The amputation should be made at one stroke, against the resistance of a hard board, and without any subsequent appliance for stopping the hæmorrhage, or, at the worst, with the use of a very moderate cautery, so applied as not to touch the bone; and every precaution should be taken that the act of amputation go clear through a joint of the tail without grazing, far less splitting an articulation of bone. The precise joint of the horse's tail through which the amputation is made, is a matter of mere caprice; some persons preferring to leave a considerable portion of the tail, and others preferring to cut almost the whole away so as to leave nothing but a hideous rump. The docking of lambs has of late years come into great vogue; and is alleged to promote cleanliness, and prevent the tormenting attraction of insects.

DODDER,—botanically *Cuscuta*. A genus of very curious, twining, epiphytous plants, of the bindweed order. The European species, *Cuscuta europæa*, is an annual parasite upon clover, lucern, and similar plants, and has long given great annoyance to the farmers of Holland and Belgium, and begins to be seriously menacing to the farmers of some districts of Britain. Its seeds are only about a sixth part of the size of those of clover; and when they exist in mixture with either sample or stock of clover seeds, can easily be separated by sifting; but when once a very few find their way into the soil, they originate races of dodder plants which extend with great rapidity, and cannot be extirpated without the utmost difficulty. "As soon as the seed of the dodder is ripe," says Dr. Lindley, "it falls to the ground, and usually seems to lie dormant till the succeeding year. When the spring returns, the embryo sends one end down into the earth to form a root; and with the other it rises upwards like a small white thread or worm. At this time, it is not a parasite, but seems to derive its food from the soil like ordinary plants. It cannot, however, do so long, but withers and perishes, unless it touches some living branch or stem. If it succeed in doing so, it immediately seizes the live stem by means of a sucker, which is protruded from the point of contact; and then, twining from left to right, and forming more suckers as it twines, it establishes itself on its victim, and ceases to have any further connexion with the soil. From that time forward it is a true parasite, feeding on the juices of the plant it has seized upon. After making a few turns round the branch, and securing itself firmly in its new position, it again lengthens, and catches hold of some other branch, when more suckers are protruded, and thus it goes on—branching, and twining, and sucking, and branching again —until it forms that appearance which Professor Henslow well describes as resembling 'fine, closely tangled, wet catgut.' Now the dodder has a new and independent seat of life wherever it has twined round a branch; and as it is incessantly twining and separating, and twining again, a single plant is speedily in the condition of a polype—so that if it be cut into a thousand pieces, each piece will immediately go on growing, as if nothing had happened to it. Tearing the dodder to pieces, then, so far from extirpating it, only multiplies the mischief instead of arresting it. This short statement will show that it is a formidable enemy that has been thus unfortunately introduced to our fields; and, as these things are not very nice in their food, it is not impossible that the clover dodder may next take a fancy to our wheat fields, unless we can speedily put an end to its presence. It is of little use to cut it in pieces,—it is of no use whatever to do so, if the fragments are left where they can catch hold of any thing else. As it is only an annual, it would be killed if we could prevent its flowering; but that is difficult, because of its hiding itself among the lower branches of plants, where it cannot well be seen; and a few heads of flowers will soon renew it in a succeeding year. The right plan would be to dig up the clover where the dodder appears, so as to form a circle considerably beyond the patch apparently formed by it, and then to burn it in heaps; or, in cases when the entire field is infected by it to sacrifice the whole crop and burn it. This may appear a violent remedy, but it is the only one likely to be effectual; and even this will fail if (which is not yet the case, but soon will be) the dodder is allowed to form its seed; for they will fall on the ground, lie hid in the crevices, and reappear with the next crop,—when all the labour will have to be done over again." — Another species, called by some the true dodder, and by others the lesser dodder, *Cuscuta epithymum*, very closely resembles the European species in character and habits, and grows indigenously on heathy grounds in both England and Scotland; and this species, in common with the other, naturally twines round furze, nettles, heaths, or any other plants it can meet with, and is sometimes called by the common people devil's-guts and hellweed. Five or six species have been introduced to curious botanical collections in Britain from Australia and the tropical parts of Asia; and about 16 other species are known. See the article Flax-Dodder.

DODDERING. The clipping away of the wool from the tail and from between the hind-legs of sheep. The object of the operation is cleanliness, and the lessening of attraction to flies.

DODECANDRIA. See Botany.

DODECATHEON. See American Cowslip.

DODONÆA. A genus of tender, evergreen shrubs, of the terebinth order. About 20 species have been introduced to Britain,—all, except one, since the beginning of the present century; and several more are known to botanists. They are green-flowered, and have a height of from 3 to 7 feet; but they are more curious than either handsome or useful. The laurel-leaved, *D. laurifolia*, a native of Australia, is probably the most interesting.

DOG. To no animal is mankind more indebted for faithful and unswerving affection than to the dog. His incorruptible fidelity, his forbearing and enduring attachment, his inexhaustible diligence, ardour, and obedience, have been noticed and eulogized from the earliest times. This valuable quadruped may be emphatically termed the friend of man; as, unlike other animals, his attachment is purely personal, and uninfluenced by changes of time or place. The dog seems to remember only the benefits which he may have received, and, instead of discovering resentment when he is chastised, exposes himself to torture, and even licks the hand from which it proceeds. Without the aid of this almost reasoning animal, how could man have resisted the attacks of the savage and ferocious tenants of the forest, or have procured sustenance in those ages of the world when agriculture was unknown!

When we attempt to trace the source or origin of the species, it will be found that the changes and varieties, which the influence of domestication and the intermixture of races have produced, are so multifarious and interminable as to baffle all research. Pennant is of opinion that the original stock of dogs in the old world is with great reason supposed to be the jackal; that from their tamed offspring, casually crossed with the wolf, the fox, and even the hyæna, have arisen the numberless forms and sizes of the canine race. Buffon, with much ingenuity, has traced out a genealogical table of all the known dogs, deducing all the other varieties from the shepherd's dog, variously affected by climate, and other casual circumstances. From the recent observations of travellers in the high northern parts of America, where, although dogs have been employed for an incalculable length of time, they still retain much of the external appearance and general carriage of a wild animal, it would seem that Pennant's suggestion is worthy of attention. But, at the same time, it should be remarked, that the breed of dogs, produced from the wolf and varieties of the domestic dog, during a long succession of generations, still retains marked characteristics of the predominance of the savage qualities derived from its untamed progenitors, in the keen and vivid expression of the eye, ferocity of disposition, and severity of bite. It is also a singular fact, that the race of European dogs evince as great an antipathy to the Esquimaux species as they do to a wolf. Linnæus has asserted that the tail of this animal, in all its species and varieties, invariably bends to the left; but, although such is very often the case, it is by no means universal, as the slightest observation will demonstrate. Desmarest, however, has remarked a peculiarity as respects the tail of dogs, which appears much better entitled to rank as a specific character; that, whenever this member is of white united with any other colour, the white is always terminal. The same remark applies to other species of this genus equally with the dogs. See article Domestication.

Naturalists have divided dogs into several classes. M. F. Cuvier has directed much attention to this subject; and he has constructed a list of dogs, arranged, as he conceives, in the order of their approach to the parent stock as far as that can be determined by the shape of the head, and the length of the jaws and muzzle. We subjoin this arrangement, which varies greatly from that of Buffon, and certainly appears much more natural and reasonable.

All the varieties of the dog, according to M. F. Cuvier, may be divided into three groups, viz.:—

I. Matins.
II. Spaniels.
III. Dogues.

I. Matins.—The anatomical character of this group is,—the head more or less elongated; the parietal bones insensibly approaching each other; and the condyles of the lower jaw placed in a horizontal line with the upper cheek teeth.

Var. A.—Dog of New Holland.—*Canis fam. Australasiæ*, Desmarest; *Dingo*, Shaw.

Var. B.—French matin.—*Canis fam. laniarius*, Linnæus; *Matin*, Buffon.

According to Buffon, this dog, a native of temperate climates, becomes the Danish dog when carried to the north, and the greyhound, when under the influence of a southern climate.

Var. C.—Danish dog.—*Canis fam. Danicus*, Desmarest; *Grand Danois*, Buffon.

Var. D.—Greyhound.—*Canis graius*, Linnæus; *Levrier*, Buffon.

This variety includes the following *sub-varieties*:

a. Irish greyhound.
b. Scotch greyhound.
c. Russian greyhound.
d. Italian greyhound.
e. Turkish greyhound.

The Italian and the Turkish greyhounds are alike in the great timidity of their dispositions, and their constant trembling proceeding probably from excessive sensibility. The common greyhound is feelingly alive to caresses; and the motions of his heart, when noticed, are most violent and irregular.

The *Albanian* dog, a very celebrated species described by many historians, belongs to this group.

II. Spaniels.—The head very moderately elongated; the parietal bones do not approach each other above the temples, but diverge and swell out so as to enlarge the forehead and the cerebral cavity. This group includes the most useful and intelligent of dogs.

Var. E.—Spaniel.—*Canis fam. extrarius*, Linnæus.

The name of this race is derived from its original country, Spain; thence Epagneul, French; Spaniel, English.

Sub-varieties.

a. The smaller spaniel.

b. King Charles's spaniel. — *Canis brevipilis*, Linnæus.

c. Le Pyrame, Buffon.—(There is no English name for this kind.)

d. The Maltese dog.—*Bichon*, Buffon.

e. The Lion dog.—*Canis leoninus*, Linnæus.

f. The Calabrian dog.

Var. F.—The Water-spaniel. — *Canis aquaticus*, Linnæus; *Chien barbet*, Buffon.

Sub-varieties.

a. Small Water-spaniel.—*Petit barbet*, Buffon.

According to Buffon and Daubenton, this is considered the offspring of the great water-dog and the little-spaniel.

b. Chien Griffon.—This is a sub-variety between the water-spaniel and shepherd's dog.

Var. G.—The hound.—*Chien Courant*, Buffon; *Canis sagax*, Linnæus.

This is essentially the same as the blood-hound. The fox-hound is a smaller variety, and the harrier a still smaller. The beagle is a particular breed of the harrier. The 'Talbot' is an old English name for all the varieties of the hound.

Var. H.—The pointer.—*Canis avicularius*, Linn.

Sub-varieties.

a. Dalmatian pointer. — *Braque de Bengal.*— Buffon.

Var. I.—Turnspit.—*Canis fam. vertagus*, Linnæus.

There are two sub-varieties, one with the fore-legs straight, the other crooked.

Var. K.—Shepherd's dog.—*Canis fam. domesticus*, Linnæus.

Var. L.—Wolf dog.—*Canis pomeranus*, Linnæus.

Var. M.—Siberian dog.—*Canis Sibericus*, Linn.

Var. N.—Esquimaux dog. — *Canis fam. Borealis*, Desmarest.

Var. O.—The Alco.

In group II. ought to be included—

The Alpine spaniel.
The Newfoundland dog.
The Setter.
The Terrier.

These are omitted by M. F. Cuvier; but the two first are alluded to in a note by M. Desmarest in his '*Mammalogie.*' The French call the various mongrel breeds *chiens de rue*—dogs of the street.

III. Dogues.—The muzzle more or less shortened; the skull high; the frontal sinuses considerable; the condyle of the lower jaw extending above the line of the upper cheek-teeth. The cranium is smaller in this group than in the two previous, owing to the formation of the head.

Var. P.—Bull-dog.—*Canis fam. molossus*, Linnæus. *Sub-variety.*—Dog of Thibet.

Var. Q.—The Mastiff.—*Canis fam. Anglicus*, Linn.

Var. R.—The Pug-dog.—*Le doguin*, Buffon.

Var. S.—The Iceland dog.—*Canis fam. islandicus*, Linnæus.

Var. T.—Little Danish dog.—*Canis fam. variegatus*, Linnæus.

When spotted with black on a white ground it is called the Harlequin dog. Notwithstanding the name there is no resemblance of form between this and the Danish dog, *var.* C.

Var. U.—Bastard pug.—*Chien roquet*, Buffon.

Var. V.—*Canis fam. Britannicus*, Desmarest.—A variety between the little Danish dog and the Pyrame.

Var. X.—Artois dog, an extinct variety of the *Canis fam. fricator of* Linnæus.

Var. Y.—Dog of Andalusia, sometimes called the Dog of Cayenne.

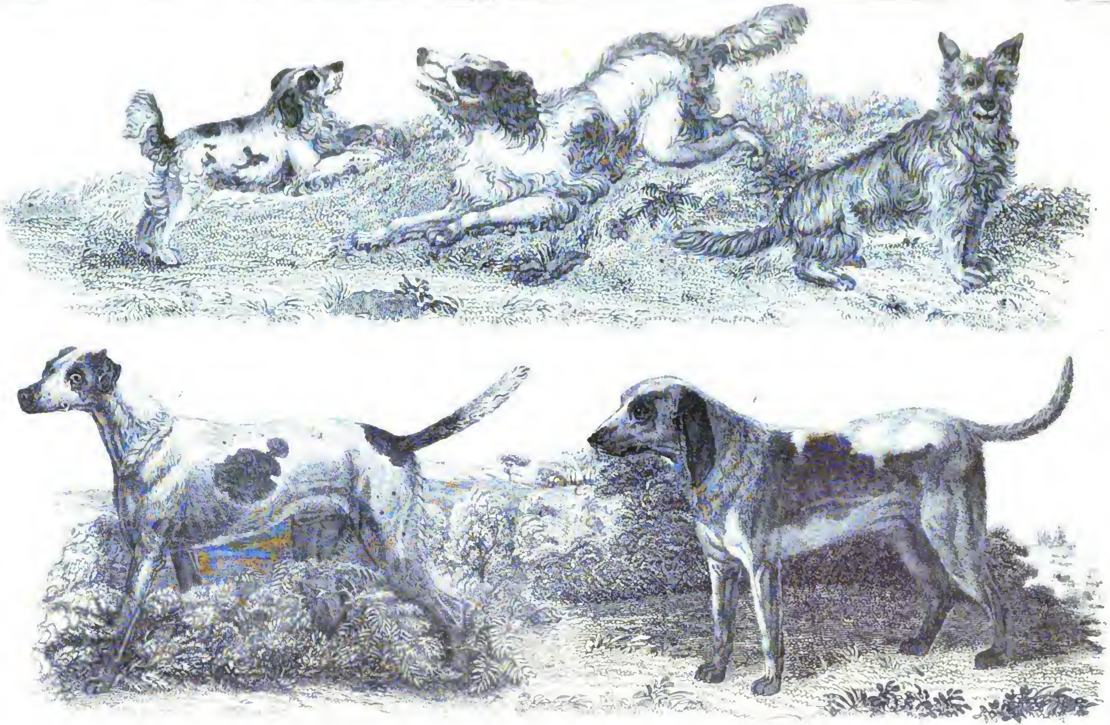
Var. Z.—Barbary dog.—*Chien turc*, Buffon; *Canis fam. Ægyptius*, Linnæus.

There are two varieties; one quite naked, the other with a mane.

In *Plate XXXII. Fig.* 1 is the English pointer; *Fig.* 2 the Springer; *Fig.* 3 the Cocker; *Fig.* 4 the Harrier; and *Fig.* 5 the Scotch terrier:—In *Plate XXXIII. Fig.* 1 is the Fox-hound; *Fig.* 2 the English terrier; and *Fig.* 5 Spanish pointers.

Dogs communicate ideas to each other by means of natural signs, and assign to each the part necessary to be performed, in a combined plan of action—qualities which require operations of their minds but little inferior to the results of the human intellect. We shall even show that they form plans, when hunting by themselves, which exactly resemble those ingenious devices invented by man, and practised by him in the art of war.

M. de Puymaurin, a member of the French parliament, had a female water-spaniel, whose education had been very carefully attended to, and it accordingly showed extraordinary intelligence. During the occupation of Paris by the allied armies in 1814, General Stewart, who lodged in M. Puymaurin's house at Toulouse, remarked that the dog would take nothing that was offered to it with the left hand, and he tried to deceive the animal by crossing his arms, and even by exciting its appetite by some marked difference in the quality of the food held in each hand, but without effect. Being determined to subject the dog to a very peculiar experiment,



he requested one of his aides-de-camp (Colonel Cameron), whose right arm had been amputated, to offer the dog some food. The dog approached, and without noticing the hand containing the food, rose upon its hind-legs, and applied its nose to the place where the colonel's right arm ought to have been, as if to be sure that there was no deception, and being satisfied that the colonel had only one arm, it passed on to his left hand and took the food. This fact was reported to M. de La Malle by M. Auguste de Paymaurin, the son of the deputy on whose authority it is inserted here.

A well-trained dog can often be brought to understand the meanings of words, even though spoken without the slightest gesture or alteration of tone. M. Edwards has been heard to mention an anecdote of a dog, which was in the habit of seeking and bringing back gloves. If in the course of conversation, when the dog would appear to be paying no attention to what was going on, any mention was made of his talents, and the word gloves (*gants*) happened to be used, the dog was off immediately seeking out for them; and when they were found, he again resumed his former position of careless listener to the conversation. Another dog, which belonged to an aunt of M. Audouin, was excited in the same way when gingerbread cakes were alluded to, of which he was very fond. If this word (*gimblettes*) happened to be mentioned in the course of conversation, and without any peculiar emphasis, he was excited and ran to the cupboard where the cakes were shut up. This experiment was often repeated before several people, who would not at first believe the statement.

M. de La Malle informs us, that one of his neighbours, the Count de Fontenay, was engaged in some agricultural speculations relating to the breeding of the merino sheep, jointly with the Marquis des Feugerets, whose property was situate about two leagues from his own. The count had a very fine pointer, possessed of great intelligence, and as he had educated this dog himself, it almost seemed to anticipate his wishes. One day he had an urgent message to communicate to his neighbour, and as no one was at hand to whom it could be intrusted, it occurred to him to try whether the dog would carry it. Accordingly he fastened the letter to Soliman's collar, and told him carelessly, and without expecting him to obey the command, "Carry that to Feugerets!" The dog did as he was desired, and would permit no one to touch the letter except the Marquis. "I have seen this dog," says M. de La Malle, "for four or five years acting as messenger between these two châteaux with a remarkable quickness and fidelity. When the dog delivers the letter, he goes to the kitchen to be fed. As soon as he has had his meal, he sits down before the window of the Marquis des Feugerets' study, and barks at intervals, to show that he is ready to take back the answer. On the letter being attached to his collar, he sets off and brings it to the count, his master."

It has been proved, beyond the possibility of doubt, that the property of pointing and setting game, which some races of dogs are made to acquire by feeding them well, and then exercising a certain degree of constraint and punishment, is transmitted unaltered to their descendants. M. Magendie, happening to hear that there was a race of dogs in England which brought back game naturally, procured two adult retrievers. These animals produced a female retriever, which always remained under M. Magendie's immediate inspection, and though it had received no instruction, it stopped and brought back game, from the very first day that it was led to the field, and this it did with a degree of steadiness fully equal to those dogs which have learned this art solely under the stern discipline of the whip and collar.

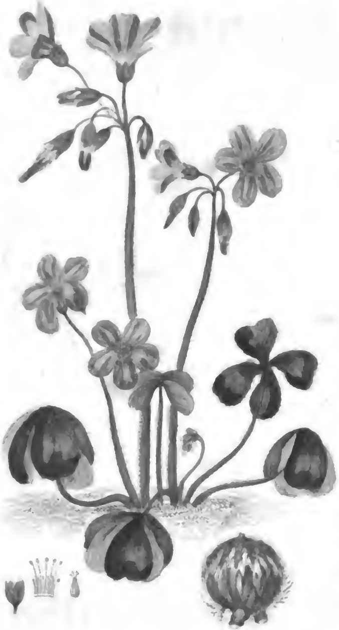
When the Spaniards discovered America, they introduced dogs as auxiliaries in their military expeditions against the Indians. Columbus first employed them for that purpose, and we are informed in his own Memoirs, that at his first conflict with the Indians, his army consisted of 200 foot soldiers, 20 horsemen, and 20 dogs. These dogs were employed in the conquest of several parts of the New World, especially in Mexico and New Grenada, wherever the resistance of the Indians was prolonged. We are informed by M. Roulin, that this race is still preserved pure on the plateau of Santa Fé, where it is used for stag-hunting. This it performs with an extreme ardour, and still uses the same mode of attack, which must have rendered it so formidable to the Indians. It consists in seizing the animal by the abdomen, and then overturning it by a sudden jerk, which is given at the moment, when the weight of its body is thrown upon the fore-legs. Sometimes the weight of the animal thus overturned is six times that of the dog.

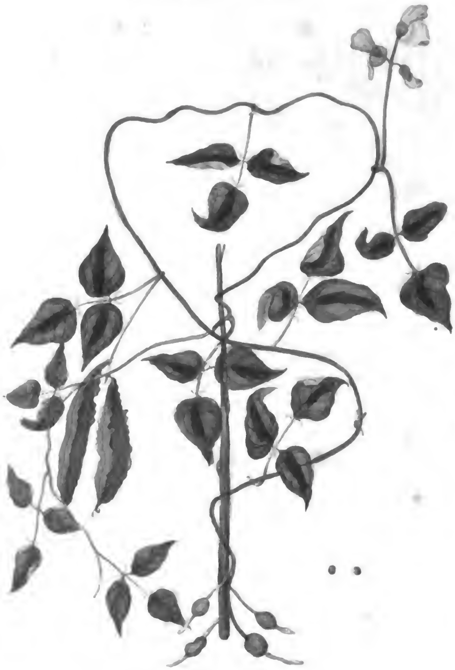
Without receiving any previous education, the dogs of pure breed, naturalized in South America, bring to the chase certain dispositions which the newly-introduced coursing dogs, though of a superior European breed, have not yet acquired. Thus, the American dogs never attack a stag in front in the middle of its course, and even when the latter comes towards a dog without perceiving him, the sagacious animal swerves to one side, and waits his opportunity to attack it in flank. A foreign dog, who is unaccustomed to these precautions, is often left dead on the spot, from having the vertebræ of his neck dislocated by the violence of the shock. Among the poor people inhabiting the banks of the Magdalena, this dog has degenerated, partly from the cross of another breed, and partly from the want of sufficient food. Even in this degenerate race, a new instinct seems to become hereditary. It has been long used exclusively in hunting the white-lipped peccari, *Dicotyles labiatus*. The art of the dog consists in moderating his ardour, and in not attacking any particular animal, but thus keeping the entire herd in check. The very first time that these dogs are brought to the chase, they show their knowledge of this art, which has been transmitted to them by their parents. A dog of a different breed rushes into the midst of the herd, is surrounded, and no matter how great his strength may be, he is devoured in an instant.

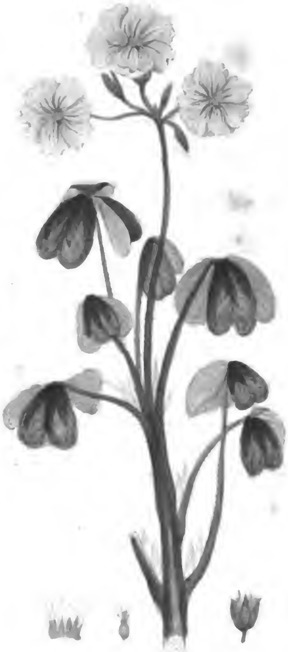
Those instances, where different varieties of the dog unite their several talents while hunting, and form one combined plan of operations, are perhaps still more striking than any of the preceding. "I had at one time," says M. de La Malle, "two sporting dogs, the one an excellent pointer with a very smooth skin, and of remarkable beauty and intelligence. The other was a spaniel, with long and thick hair, but which had not been taught to point, and only coursed in the woods like a harrier. My château is situate on a level spot of ground opposite to a copse-wood filled with hares and rabbits. When sitting at my window, I have observed these two dogs, which were at large in the yard, approach and make signs to each other, and first glancing at me as if to see whether I offered any obstacle to their wishes, slip away very gently, then quicken their pace when they were a little distance from my sight, and finally dart off at full speed when they thought I could neither see them nor order them back. Surprised at this mysterious manœuvre, I followed them, and witnessed a singular sight. The pointer, who seemed to be the leader of the enterprise, had sent the spaniel out to beat the bushes, and give tongue at the opposite extremity of the brushwood. As to himself, he made with slow steps the circuit of the wood, by following it along the border, and I observed him stop before a passage much frequented by the rabbits, and there point. I continued at a distance to observe how this intrigue was going to end. At length, I heard the spaniel, which had started a hare, drive it with much tongue towards the place where his companion was lying in ambush, and the moment that the hare came out of the passage to gain the fields, the latter darted upon it, and brought it towards me with an air of triumph. I have seen these two dogs repeat the same manœuvre, and in the same manner, more than a hundred times; and this conformity has convinced me that it was not accidental, but the result of a concerted agreement and combined plan of operations arranged beforehand." Leroy was of opinion that wolves do the same thing; but he founded his conclusions solely upon the traces of their foot-marks left on the snow or mud. The same thing has been said by hunters respecting foxes, but the truth of it is very doubtful. Indeed, these wild animals which hunt during the night, especially when timid, are so difficult to observe, that these assertions require further confirmation, when made of animals known to be of solitary habits.

The fact that the domestic dogs often combine their different talents to execute one manœuvre, is further corroborated by M. Louis Châteaubriand, nephew of the celebrated writer, who has witnessed the same thing between two harriers and a pointer. It is clear, that whatever differences there may be between this contrivance of the dogs, and the ambuscade of a skilful general who hides his forces in the woods or copses, and sends a small body of troops with orders to fall back before the enemy, and draw them on towards the defiles, they both agree in being an ambuscade—a trick played upon the credulity of the enemy, and require the same operations of the mind to direct them both. The workings of sympathy among the domestic animals are very striking, and the observations of M. de La Malle on this point have served to lead the way towards a better acquaintance with its powerful influence. Having been educated in the country during the earlier part of his life, he had amused himself with imitating the cries of many wild and domestic animals, and from habit he acquired a skill so great, as to deceive the animals themselves. In this way, by expressing after their own manner the external signs of pain, anger, or desire, he could excite the same passions in them, and call forth at pleasure the external signs of those passions. By numerous experiments, he found that the imitation of the sound always produced a sympathetic effect, and he thus succeeded with dogs, cats, asses, cocks, hens, &c., in producing the same results as a good comic or tragic actor upon an assembled audience, and in making the house cry or laugh, according as his voice and gestures excited the emotions of grief or joy. By yawning, and at the same time imitating the sound which accompanies the yawn, dogs may be made to yawn at pleasure; but to succeed in the experiment, the animals must be lying quiet for some time. If they be moving or in the field, their attention will be otherwise engaged. When several dogs are lying down together, the first that yawns makes all the others follow, except those which have their attention occupied about any passing matter.

We must, however, refuse to assign moral qualities, or the faculty of discerning right from wrong, to these lower animals, if the above phenomena admit of being explained on the common principles of habit, or the association of ideas. When a dog has long been accustomed to perform a disagreeable office every fourth day, he will come in the course of time to know his particular day of service, and a more frequent demand will naturally excite his resentment. To assign moral qualities to the lower animals is a very popular error, and we are inclined to suspect that these eminent philosophers allowed themselves to be deceived by the ambiguous language of the country people. It is a common circumstance to see a dog, after having committed some fault for which he has often been punished, enter the room slowly and







sneak into a corner; some one then observes, 'He knows he has done wrong.' In this case, the dog only infers that the same action will be followed by the same punishment; or, in other words, he reasons from analogy. But this is far from entitling him to the rank of a moral being, or one capable of distinguishing right from wrong; and it is plainly unphilosophical to multiply the mental powers of animals, if the ordinary operations of intelligence are sufficient to explain all the facts hitherto authenticated.

These animals form an important article of food among many nations. In China, the Society islands, &c., young puppies are considered a great delicacy, and are allowed by Europeans, who have overcome their prejudices, to be very sweet and palatable. This taste for dog's flesh is of very early origin. The ancients regarded a young and fat dog as excellent food; and Hippocrates placed it on a footing with mutton and pork, and, in another place, observes, that the flesh of a grown dog is wholesome and nourishing. The Romans admired sucking puppies, and sacrificed them to the gods, as the most acceptable offering.

The dog is born with its eyes closed; they do not become opened until the tenth or twelfth day; its teeth begin to change about the fourth month, and its growth is perfected in two years. The female generally has a litter of from six to twelve pups. The dog seldom lives beyond fifteen years. See BLOODHOUND, BULL-DOG, GREYHOUND, HOUND, MASTIFF, POINTER, SPANIEL, SHEPHERD'S DOG.

DOG-BRAMBLE,—botanically *Ribes cynosbati.* A hardy, ornamental, deciduous shrub, of the currant genus. It is a native of Canada, and was brought to Britain soon after the middle of last century. It grows about 4 or 5 feet high, and flowers in April.

DOG-DAYS. This name is applied to the period between the 24th July and 24th August, because the dog-star (Sirius), during this period, rises with the sun. The heat, which is usually most oppressive at this season, was formerly ascribed to the conjunction of this star with the sun.

DOG-POISON. See FOOL'S PARSLEY.

DOG'S-BANE,—botanically *Apocynum.* A genus of herbaceous plants, constituting the type of the natural order Apocyneæ. This order is characterized, to even a popular observer, by the twisted direction of the parts or segments of its corolla; and consists of plants which Linnæus called Contortæ, and whose flowers present some resemblance in form to a St. Catharine's wheel. It comprises 36 genera, and has, within the gardens of Great Britain, about 120 hothouse species, about 15 greenhouse species, and 9 or 10 hardy species. Many of its plants are among the most elegant climbers of the tropics; and not a few are either poisonous or powerfully medicinal; while three or four are, in various ways, economical.

The genus Apocynum comprises four hardy, perennial-rooted, ornamental species, which have been introduced from Venice and North America; and eight or nine other species which have not yet been introduced. The hemp-like species, or hemp dog's-bane, or Canadian hemp, *Apocynum cannabinum*, was introduced from North America in 1699; but, though a valuable plant for its fibre, has hitherto been almost wholly confined with us to mere botanical collections. Its roots are creeping; its stems are erect, unbranching, and about 4 feet high; its leaves are opposite, oblong, and downy beneath; and its flowers are yellowish and bell-shaped, and grow in lateral cymes which are longer than the leaves, and bloom from July till September. This plant has been proved by Professor Thouin of Paris to possess a stronger fibre than that of hemp; and it is used by the American Indians for making cordage, fishing-nets, and coarse cloth.—The name of dog's-bane or tall dog's-bane belongs also to a French species of monkshood, *Aconitum cynoctonum;* and both in this case and in that of the apocynums, it alludes to the noxiousness of the juices to dogs.

DOG'S-BANE (CLIMBING). See PERIPLOCA.

DOG'S CABBAGE,—botanically *Thelygonum Cynocrambe.* A trailing annual plant, of the nettle family. It constitutes a genus of itself. It is a native of the south of Europe, and was introduced to Britain in the early part of last century. It may be raised from seeds in any spot of kitchen-garden ground; but it possesses little value.

DOG'S-TAIL GRASS. See CYNOSURUS.

DOG'S-TOOTH VIOLET,—botanically *Erythronium.* A genus of hardy, ornamental, tuberous-rooted, low-growing plants, of the lily family. The common species, *Erythronium Dens Canis*, is a native of several parts of continental Europe, and was introduced to Britain toward the close of the 16th century. Two oval leaves, each about 3 inches long and 1½ inch broad, grow from the plant at the surface of the ground, and are joined to each other at the base, but afterwards spread flat upon the ground; and these are spotted, all over their surface, with white and purple spots, so as to have an unique and very curious appearance. The flower stem is single and naked, and rises from between the leaves to a height of about 4 inches; and the flower is single, purple, pendant, and six-petalled, with the petals reflexed and spreading. One variety has white flowers; and another has smallish flowers. Three other species occur in British gardens: and two of these have long been in cultivation.

DOGWOOD,—botanically *Cornus.* A genus of hardy ornamental plants, of the honeysuckle family. The common or bloody-twig species, *Cornus sanguinea*, grows wild in the woods and hedges of many parts of Great Britain, and also has a place in multitudes of shrubberies. It is a deciduous shrub of about 8 or 9 feet in mature height. Its twigs or young shoots have a lively red colour, and are alluded to in the epithet sanguinea; its leaves are about two inches long and 1½ inch broad, and have large and prominent nerves, and frequently have a red colour before their autumnal fall; its flowers are white, and grow in umbels at the ends of the branches, and appear in June and July; and its fruit are black berries, similar to those of buckthorn, but each containing only one seed. The wood of the stem and the branches is brittle and exceedingly white, and has long had the reputation of being pre-eminently suited for gunpowder-charcoal.—The male dogwood, male cornel, or Cornelian cherry, *Cornus mascula*, is a native of Austria, and was introduced to Britain in 1596. It attains a height of from 15 to 20 feet, flowers early in spring, and makes an imposing show of beautiful scarlet berries in autumn. Its wood is used for pins, wheel-work, hedges, and other purposes; and its fruit was formerly held in considerable esteem.—About ten other deciduously shrubby species, and two low-growing utterly dwarfish herbaceous species, exist in Britain; and five or six additional species are known to botanists. Three of the shrubby species comprise variegated varieties; and one of the herbaceous species is a native of the Scottish mountains. Most of the shrubs may be readily propagated by means of either layers or cuttings.

DOLE, or Dool. A long narrow piece of unploughed grassy land within the enclosures of an arable field.

DOLICHOS. A genus of climbing plants, of the kidney-bean division of the leguminous order. It differs from the kidney-bean genus, principally in the form of its flowers; and is closely akin to it in at once structure, habits, and utility. Many species formerly belonging to it are now distributed among thirteen other genera; but nearly 30 species which still belong to it occur in the gardens and botanical collections of Britain, and nearly 20 more have been scientifically described. A number of the species are cultivated in India, the south of Europe, and other warm parts of the world; but most of these are inferior in value to the kidney-beans, and nearly all are too tender for cultivation in the open ground of even the most favourable districts in England. The Catjang or small-fruited species, *D. Catiang*, a purple-flowered annual of about a yard in height, is cultivated in India, and much prized as pulse by the Hindoos. The Tranquebar species, *D. tranquebaricus*, a white and purple flowered annual of about a yard in height, with a long, slender, pleasant-tasted legume, is also cultivated in India. Eight or ten of the species which have either been transferred to other genera, or have not yet been introduced to Britain, are likewise commonly cultivated by the Hindoos. The black-eyed species, *D. melanopthalmus*, a somewhat hardy annual of about a yard in height, is cultivated in Italy. The round-seeded species, *D. sphærospermos*, an annual of about 4 feet in height, is cultivated in the West Indies. The variable-leaved species, *D. heterophyllus*, an annual of about 5 feet in height, is cultivated in the Canaries. The monk's species, *D. monachalis*, a somewhat hardy annual of about 2 feet in height, with a pale red flower, is cultivated in Spain. The Lubia, *D. Lubia*, a somewhat hardy annual, of about 20 inches in height, with a white and blue flower, is cultivated in Egypt. The vexillated species, *D. vexillatus*, called by Linnæus *Phaseolus vexillatus*, a yellow-flowered annual of about a yard in height, is cultivated in the West Indies. The clawed or bird's-foot species, *D. unguiculatus*, a yellow-flowered annual of about a yard in height, is also cultivated in the West Indies. The long-podded species, *D. sesquipedalis*, a white-flowered annual, with a stem about two yards in height, and pods of about 18 inches in length, is likewise cultivated in the West Indies. The square-podded species, *D. tetragonolobus*, called by Necker *Psophocarpus tetragonolobus*, a blue-flowered annual of about 4 feet in height, is cultivated in various warm countries, and was introduced to Britain about 30 years ago, from the Mauritius. "The dolichos tetragonolobus," says Mr. W. Hamilton, "is a most valuable agricultural plant; as, when sown about November, December or January, it covers the ground with a dense mass of vegetation, effectually securing the soil from the action of the sun, and affording a most nutritious pasturage for cows, who devour it greedily when penned upon it, giving an increased quantity of milk, and enriching the ground both with their manure, and with the quantity of unconsumed vegetable matter which they tread into the ground. The plant flowers about July and August, and, if sown over that time, flowers and dies without any luxuriance of growth. The pods resemble those of the stizolobium pruriens," Mucuna urens or cowitch, "but want the stinging pubescence. They, are, however, when young, often mistaken for this last, and eradicated in consequence. The young leaves resemble Windsor beans, and are excellent for the table; but as they advance to maturity, they become unwholesome, and produce disorders of the stomach and bowels."

DOLPHIN-FLY. The bean-dolphin. See Aphis.

DOMAIN, Demain, or Demesne. In its popular sense, the lord's manor-place, with the lands thereto belonging, which he and his ancestors have from time to time kept in their own occupation. In England the domains of the Crown denote either the share reserved to the Crown in the distribution of landed property at the time of the Conquest, or such as came to it afterwards, by forfeitures or other means. They are, at present, contracted within a very narrow compass, having been almost entirely granted to private subjects; and though this was often done in a most injudicious manner, it has been of great benefit by diminishing the power of the Crown, and making it dependent on the grants of parliament; whilst, in many other countries, the wealth of the Crown has rendered it independent, and strong enough to oppress the subjects, and undertake wars injurious to the public welfare. The rents and profits of the demesne lands of the Crown constitute, at present, one branch of the sovereign of England's ordinary revenue.

DOMESTICATION. Animals, whether domesticated or in a wild state, always preserve their real characters, and act in a manner suited to their situation. The absolute submission which we are in the habit of requiring from our domestic animals, and that kind of tyranny which we exercise over them, have given rise to the belief that they are really slaves. It is commonly supposed that our superior power *compels* them to resign their natural fondness for independence, to yield implicit obedience to our will, and to perform those offices for which they are adapted by their organization, intelligence, and instincts. We are in the habit of attributing to our own influence the submission obtained from these animals; *we* are imagined to be the source of those instincts developed under domestication, and to have commanded obedience, just as our superior power maintains them in captivity. This conclusion is, however, altogether fallacious. Judging from appearances only, we have confounded two things totally distinct in their nature, namely, domestication and slavery. Domestication is a state of freedom, and hence the difference between the human slave and the domesticated animal is as great as that between slavery and liberty.

The domesticated animal makes use of its natural faculties within the limits marked out by its situation, in a manner exactly similar to the wild animal in the woods. Being never urged to act except by external causes, or by internal instincts, as soon as its will has conformed itself to the constraints of its situation it makes no farther sacrifice. The animal, in fact, is not in reality in a different situation from what it would have been if left to itself. It lives, without constraint, in society with man, because doubtless it was naturally a sociable animal. It conforms itself to the will of man within certain limits, because its herd would have had a leader in the strongest or most active animal, to whom submission would have been naturally paid. If a dog is by our care rendered a good courser, it is because he was a hunter by nature, and we have only developed one of his original qualities. The same rule is observed in all the different qualities which we impart to our domestic animals. They perform nothing which is not agreeable to their nature; in doing so, they only fulfil the original purposes for which they were formed; they never acquire different qualities, and thus enjoy, under man, a perfect state of liberty. It is true that man possesses an immense power over the domestic animals, and one which he often abuses. Yet he usually developes qualities natural to the animal; hence it acquires a degree of improvement unattainable in its original state, and thus its condition really becomes ameliorated. Thus we may see the immense difference between slavery and domestication. The slave is not only a social being, with a power of willing, but he is naturally a free being, whose mind cannot confine itself spontaneously to the situation in which he is placed. He knows his condition, considers its consequences, and feels its oppression. The natural power which he possesses of reflecting upon his situation, shows it to him in all its degradation. He feels that he is in chains, that he cannot use his natural free-will, and that he is a degraded being. On the contrary, a domestic animal satisfies all its wants; hence it lives in a state of nature, and is conformable to the situation in which it is placed. The slave who is compelled to renounce his free-will is far from being in the same condition. He holds the same rank in the moral as a mutilated being or a monster in the physical world.

The essential difference between these two states is further seen in the opposite means which are employed to enforce them. A man can only be reduced to slavery, and maintained in it, by violence; because it is the very nature of liberty to be unrestrained. An animal can only be domesticated by kindness. Its will exists, and shows itself only in its wants, and it can only be acted upon through its necessities, either by satisfying or enfeebling them. Violence is altogether useless in disposing a wild animal to obedience. As it has a natural aversion to man from his being of a different species, it runs away, if at large, upon the first impression of fear which he occasions, and if captive maintains a determined hatred towards him. It is only by restoring confidence that it can ever be rendered familiar to him, and this can be effected only by kind treatment. It is thus that the social instinct of the animal becomes gradually developed, and its natural feeling or distrust of everything which is new or strange becomes proportionally weaker.

The methods to be adopted in taming an animal are as various as the creatures themselves. Each process must be adapted to the peculiar likings of the animal. To satisfy its natural wants is one method which, in the course of time, brings on its entire submission, especially when applied to a very young animal. The habit of receiving its food constantly from our hands renders it familiar, and finally it becomes attached. But, except when very long continued, the attachments thus formed are but slight. The benefits which the animal thus procures it could have obtained of itself, had it been allowed to fulfil its natural disposition. As soon as we attempt to bend it to any particular service it runs away, and quickly returns to its original independence. It is therefore necessary, not only to satisfy its original and natural wants, but, by creating in it new wants and enjoyments, to render the society of man absolutely necessary to its existence. Hunger is one of the most powerful means of taming animals. As the extent of the benefit conferred is always in proportion to the want of the person relieved, so the gratitude of the animal is more profound according as the food given to it was the more necessary. This method is applicable to all the mammalia. It gives rise to a feeling of affection on the part of the animal, and at the same time produces a physical debility which reacts upon and enfeebles its will. It is thus that the education of horses begins, when they have passed their first years in a wild state. On being first caught, a very small quantity of food is given to them, and at very long intervals of time. They hence become gradually familiarized to their keeper, and acquire a certain degree of affection for him, which he readily turns to his own advantage, and thus confirms his power. If to the influence of hunger that of delicious food be added, the empire of kindness becomes greatly extended; and this power arrives to a degree perfectly astonishing, if we can succeed in pleasing the palate of animals by any kind of confectionary or cookery, in a higher degree than could have been done by the best food attainable in their wild state. In fact, it is chiefly by means of dainties, especially of sweetmeats, that the herbivorous animals can be induced to go through those wonderful feats and exercises which may often be witnessed in the circus. These delicacies influence the will of the animal to such a degree, that starvation and physical deprivations become no longer necessary. In a short time it acquires a high degree of affection for those who contribute to its enjoyment, and willingly performs whatever they may require.

But the services rendered by animals do not always proceed from so selfish an origin. Caresses are one chief means of gaining their affection, which cannot be termed sensual, because these are addressed to no particular sense. Their fondness for caresses is altogether an acquired taste, no wild animal requires them from others of its own species. Even among our domestic animals, we see the young rejoice at the approach of their mother, the male and female happy in each other's society, individuals accustomed to live together pleased to meet again after having been separated; but these feelings are always accompanied with much reserve, and they never extend to reciprocal caresses. It is from man alone that they receive them, and their attachment to him increases with the strength of the acquired taste for them. The pleasure of animals may be further heightened by a soft tone of voice, or even by touching their mammæ. All animals are not sensible to caresses in an equal degree. The ruminating animals seem but slightly influenced by them; the horse on the contrary enjoys them with ecstacy; it is the same with many Pachydermata, and especially with the elephant. The cat is not indifferent to them; sometimes even it seeks them with ardour; but it is unquestionably in the dog that the influence of caresses produces the most marked results; and what is remarkable, all the other varieties of the genus Canis, which have been hitherto observed, share this quality with him. M. F. Cuvier mentions, that in the Menagerie du Roi there was a she-wolf, upon whom caresses with the hand and voice produced so powerful an effect as almost to amount to a state of delirium, and her joy was exhibited as much by cries as by movements. A jackal from Senegal was similarly influenced when treated in the same manner; and a common fox was so forcibly affected by them, that it was necessary to abstain from all demonstrations of this kind, as the result might have been fatal to the animal. It will be interesting to know that all these animals were females. It may be doubted whether we should consider the chanting of airs, or the sound of bells, amongst those artificial pleasures by means of which animals are gratified and captivated. The songs of the camel-driver are perhaps only the simple signs by which the camels learn to mend or slacken their pace. That animals may continue to perform those acts of docility which we require from them, caresses must follow as well as precede their performance. The constraint employed in urging them to act would, if too long continued, have an injurious effect. It is then only by repeating their delicacies or caresses that the calmness and confidence is restored.

When once familiarity and confidence prevail on the part of the animal by means of kind treatment, and that habit has rendered the society of man necessary to it, we may then venture to use higher degrees of constraint, and even to inflict punishment. But our means of severity are very limited. We can only use blows, with certain precautions to prevent the chastised animal from running away. Punishment always produces the same effect; it changes the disposition which we wish to suppress into fear. By the association of ideas, the former impression yields, or is entirely merged into the latter. It is always dangerous to carry the punishment of an animal to excess. Violent fear may either totally intimidate the animal and render it for ever useless, or else it drives it to despair, and it becomes altogether ferocious and unmanageable. A horse, naturally timid, if corrected imprudently, plunges in the madness of its fright, along with its rider, into the deepest abyss. The spaniel when kindly treated is intelligent, docile to its master, and in every respect fitted for sporting; yet if an undue severity has been used in its education, it is undecided, hasty, or cringing. When once the severity of punishment has passed a certain limit, which varies in species and even in individuals, the animal begins to resist. In a moment, the instinct of self-preservation awakes in all its force. Thus we often see our domestic animals, and even the dog itself, revolt against ill usage, and inflict the most cruel punishment on its perpetrators. Many instances might be adduced of vengeance inflicted by the domestic animals, especially by the horse, against those who have ill-treated them, as well as the hatred shown by these animals, and the very long time for which this feeling of aversion has preserved its force. The cases are numerous and well known; and although they have long demonstrated that brutality is not the way to obtain obedience from animals, these creatures still continue to be treated as if it were unnecessary to court their compliance. One example of an elephant may be mentioned here, which happened under the eyes of M. F. Cuvier. This animal had been intrusted, when three or four years old, to a young man who took charge of it, and had trained it to perform various feats for the amusement of the public. It paid implicit obedience, and seemed to feel a tender affection for him. It not only yielded, without a moment's hesitation, to all his commands, but seemed absolutely unhappy without him. It rejected the attentions of any other persons, and even ate its food with sadness, when given by the hand of any other individual. While this young man remained under the eyes of his father, who owned the elephant, he always treated it properly; but when it was transferred to the Menagerie du Roi, and that the young man was thus left to himself, his attentions diminished, the wants of the animal were neglected, and in a moment of drunkenness he went so far as to strike the elephant. The poor animal immediately lost its habitual gaiety; it became so sad and dejected that it was supposed to be unwell. It, however, still obeyed the keeper, but no longer performed its exercises with the same alacrity as heretofore. Signs of impatience were sometimes shown, and then suppressed, as if two opposite feelings were in secret conflict; the animal became less disposed to obey, which increased the discontent of its leader. It was in vain that orders were given to the young man on no account to strike the elephant, whose former docility could only be restored by the kindest treatment. Vexed at having lost his authority, and in not being able to exhibit the feats of the elephant with his former success, his irritation increased, and one day he struck the animal with so much brutality that it became excited to the utmost pitch of fury, and uttered such a yell that its terrified keeper, who heard it for the first time, was glad to escape its vengeance. Never afterwards would the animal permit him to approach; even at the sight of him it became enraged, and all attempts to manage it were unsuccessful. It became wholly untractable, and no longer could be induced to perform for the amusement of the public. It thus appears that kindness on our part is absolutely necessary to dispose animals to obedience, and that interest as well as humanity agree in pointing out the same course for the proper management of their instincts.

The different methods of taming wild animals now pointed out, are completely applicable only to those animals which are susceptible of affection and of fear. When animals feel a certain degree of attachment for kindness received, or when they dread the repetition of punishment, it is sufficient merely to recall these emotions to produce an immediate effect upon their will. It often happens, however, from the peculiar nature of individuals or of species, that certain habits or likings have acquired so powerful an influence, that no other emotion can maintain the ascendency. With animals of this character, neither kindness nor punishment has any effect; and if persisted in, they would tend but to increase their constitutional bias. It is only by acting immediately upon their will, so as to weaken the force of the ruling passion, that they can be rendered susceptible of gratitude or of fear. With tempers so refractory as these, the only means of domestication hitherto discovered are forced watches and castration.

Without proceeding to actual mutilation, it appears that of all methods forced watches exercise the most powerful influence in enfeebling the will of an animal, and in disposing it to obedience, especially when united to a prudent combination of rewards and punishments. Animals may be prevented from sleeping by applying the whip more or less frequently, or still more effectually by a loud reverberating noise, such as that of a drum or trumpet, which must be varied so as to avoid the effect of uniformity. By keeping them long without food, and then feeding them slightly during their usual time of sleep, the same effect may also be produced. This method is applicable to all animals and to both sexes, although it does not always produce the same result.

The other method, that of castration, applies to male individuals solely, and is absolutely necessary only with certain ruminating animals, but chiefly with the bull. All the other animal appetites, which were given for the preservation of the individual, such as hunger, thirst, and the desire of sleep, when opposed, lead to an immediate physical debility on the part of the animal. Those passions, on the contrary, which were given for the continuation of the species, increase in proportion to the obstacles presented to their gratification. Hence it is only by depriving them of the organs from which these passions derive their source that we can bring them under our power. In fact, the bull, the ram, and other ruminants, can be domesticated solely after having undergone this mutilation. We may thus perceive the error of holding out the ox and the sheep as models of patience and submission. So far from this being really the case, the bull and the ram can only be used for propagation; and we have merely succeeded in domesticating the females of these races. This operation is not necessary for horses, although such as have undergone it are generally more tractable than the others. The dog loses by castration his entire vigour and activity; and this appears to be its usual effect upon other Carnassiers, for we find that the domestic cat is affected in the same manner as the dog. It thus appears from the preceding observations, that we can only obtain an authority over animals by means of their natural wants and propensities, by giving them a new direction, by developing, or else by annihilating them altogether.

The very small number of animals which we have hitherto succeeded in rendering practically useful, when compared with the total number of species, renders it extremely probable that we have not yet carried the art of domestication to its extreme limit, and that hereafter we shall discover the means of training new species to our use, as well as more perfect methods of educating the old.

It may easily be gathered from what has been already said, that the arts of taming present very different results when applied to animals of different species. There can be no comparison, for example, between the dog and the buffalo. The former is devoted in his attachments, submissive, and grateful; the latter wants docility, and indeed every benevolent affection. Between these two extremes, we may range in their order of susceptibility, the elephant, the hog, the horse, the ass, the dromedary, the camel, the llamas, the reindeer, the stag, the ram, and the bull.

Had we been compelled, with each generation of animals, to begin anew the process of taming, we should not, properly speaking, ever have had domestic animals. At least their domestication would not have had its full effect, and the important consequences to the civilization of the human race would not have followed in its train. Such would have been the result, had there not existed a most important general law, which is found also to prevail in every department of animated life,—that the changes undergone by the first tame animals did not die along with them, but were transmitted to their offspring. It is a well-known fact, that the young of all animals bear a great resemblance to their parents. This fact is equally true in regard to the human race, and seems not merely to be confined to their physical qualities, but to extend also to their moral and intellectual capabilities. Yet there are certain subordinate points in which animals depart from their original type, and these arise from the circumstances under which they have lived—such as the quantity or quality of their food, confinement, shelter from the inclemencies of the weather, the attentions or punishments of man. It therefore follows, that those qualities which parents may transmit to their young are capable of being influenced by accidental circumstances, and hence we are able to modify animals and their descendants within certain limits, or, in other words, to form domestic races. Thus we have given rise to numerous varieties of the horse and the dog. Each breed or race possesses some qualities which adapt it for certain purposes in preference to any other race, and these are transmitted to its descendants as long as a course of opposite circumstances do not arise to disturb the effects of the former. For these reasons, we are obliged to adopt various means to preserve the purity of the several races, or else to obtain, by the crossing of races, new or intermediate qualities to those already formed.

We may also observe, that those races which are the most domesticated, and the most attached to man, are precisely such as have received the action of the greater number of means for attaching them to his person. The dogs, for example, upon whom, whether male or female, caresses have so powerful an effect, are undoubtedly the most domesticated of all animals; while the bull, which is only attached to us through its food, and whose females are alone subjected to us, is certainly the least domesticated. This difference between the dog and the bull is farther increased by the difference in the fecundity of the two species. The dog submits to our influence a much greater number of generations, in a given time, than the bull. We are, of course, ignorant of the circumstances which induced the dog to attach itself to man, at the commencement, and also the manner in which he was reduced to his present state of submission; but everything leads us to believe that his original disposition must have been exceedingly favourable to domestication. From the great facility with which the elephant is tamed, we may conclude that if he were induced to breed in captivity, a race of domestic elephants might be formed, rivalling the dog in submission and attachment. Hitherto this has not been fairly tried; no attention has been paid, until very lately, to the breeding of captive elephants; and even in those warm countries where their services are most necessary, wild elephants are caught and tamed, while no efforts are made to transmit these acquired characters to their descendants.

An excessive fondness for society seems, however, to be another quality necessary to form a true state of domestication, besides that power just explained of transmitting to posterity their acquired instincts. There was originally a natural sociability of disposition in all the domesticated animals which assisted our efforts. Had they all resembled the wolf, the fox, and the hyæna, in their fondness for solitude,—had they always avoided the presence of their own species, —it is difficult to suppose that we ever could have been successful in our attempts. Perhaps, indeed, we might have succeeded, by long continued perseverance through a course of generations, in forming a race, domesticated to a certain point only, which would acquire a habit of living along with us, until our luxuries would become almost necessary to it, as has been done in the case of the domestic cat; but the difference between this sullen state of a mere toleration of man and a real domestication is very great. We may also rest assured, that, had not these animals originally presented some striking partiality for the society of the human race, the attempt to domesticate them would never have been made. It thus appears evident that the possession of great intelligence, of a general mildness of character, and a susceptibility to rewards or punishments, are insufficient of themselves to produce domestication. Without dispositions naturally social, the animals now domesticated never could have been induced to attach themselves to man, and to place themselves under his protection.

There are many social animals which cannot be domesticated; but it is an observation which holds true without one single exception, that all the domesticated animals form troops or herds, more or less numerous, whether they are observed in the wild state, or whether we consider only those portions of them which, being left to themselves, have reverted to their original state of wildness. On the other hand, no solitary species, however easily it may be tamed, has ever given rise to domestic races.

Whenever we succeed by kindness to attach an animal, naturally sociable, to our persons, we merely induce it to transfer, for our own advantage, that allegiance which it would naturally have paid to other animals of its own species. The habit of living with us becomes to it a necessary of life; and the sheep, which has been brought up by our care, follows its keeper just as it would have followed the flock in which it was born. Our superior intelligence soon destroys all equality between ourselves and these animals; our will guides them in the same manner as the strongest stallion of the herd would have become the chief, and be followed by all the weaker individuals of which his herd is composed. The submission with which animals obey us is not greater than what they would have yielded to their natural leader in the field. It is true that our power is greater than his, because our means of persuasion are more numerous, and we are able to suppress the greater number of those wants which, in the wild state, would have estranged them from their leader. It may be said that the hack-horse which has passed from hand to hand, and been owned by numerous masters, so that all its natural attachments are weakened, if not altogether effaced, appears to have the same degree of docility to every person, and to be in a manner obedient to the entire human race; and we must admit that this case has no corresponding situation in the wild herd. But this objection will have no weight when we consider, that when an animal, whether isolated or in a herd, has had only one master, it is to him alone that he yields obedience and pays his allegiance. Every other person is disowned or even treated as an enemy, just as a strange animal or the member of another society would be in a wild herd. The elephant allows himself to be guided solely by the Mohout whom he has adopted. Even the dog, when brought up in solitude with his master, is fierce to all other men; and every one is aware of the danger of intruding among a herd of cows, in pastures which are but little frequented without being accompanied by the herdsman. Thus, every animal which acknowledges man as the chief of his herd is domesticated. The converse is equally true, as man could not enter into such a society without immediately becoming the chief. From these observations it will readily appear, that in domesticating the inferior animals, man has only become a member of that society which these animals form among themselves, and the authority he has acquired rests solely upon the superiority of his intelligence.

Although the original and constitutional powers of animals remain the same under all circumstances, we have seen that they may undergo some very considerable modifications. It has also been shown that, in many instances, their acquired characters are transmitted to posterity. The latter conclusion has been doubted by several naturalists, who are inclined to consider their acquired characters as resulting either from the principle of imitation, the influence of situation, or a combination of these causes. It has been asserted that no modification, induced after birth in the intelligent powers or instincts of an animal, is capable of being transmitted to its offspring, and that all transmitted powers must be connate, that is, imparted with the vital existence. With the human race there must always be an extreme difficulty in ascertaining how far those hereditary characters, so often observed to prevail in particular families, are the result of physical constitution or of imitation and situation; but it is abundantly evident that the acquired properties of the lower animals are sometimes transmitted to posterity. The races of rabbits which wholly lose their instinct of burrowing from confinement;—the young foxes of thickly-peopled countries which inherit the acquired cunning of their parents;—the young pointers which set game naturally and without any previous instruction;—and the excessive timidity of young lap-dogs, whose parents have been long in the company of timid females;—are instances of this fact. Further, we have, in the docility of those races which have long been domesticated, an evident proof that the modifications of the earlier-tamed animals were transmitted to posterity, while the apes of Samatra, which have not this transmitting power, are wholly incapable of yielding domestic races. It must, however, be carefully observed, that animals do not transmit to their posterity *all* their acquired modifications. On the contrary, it is only a *very small* number of acquired habits or alterations which are thus transmitted to their descendants. Nearly all those arts which a well-trained dog has acquired perish with the individual, and the process of education has to be recommenced with the pup. The reverse takes place with the other kind of modifications which are properly connate or born with the animal; for the latter are very frequently inherited by their descendants, and the instances of their not being so transmitted are by no means numerous. Thus, the artificial modifications of instincts and intelligence *sometimes* become hereditary; but connate modifications *usually* are so. The latter is remarkably the case in man. "We see," says Dugald Stewart, "one race, for a succession of generations, is distinguished by a genius for the abstract sciences, while it is deficient in vivacity, in imagination, and in taste; another is no less distinguished for wit, gaiety, and fancy, while it appears incapable of patient attention or of profound research." We have many remarkable instances of the transmission of connate varieties, in the intellectual qualities of the several races of dogs. No care or education will induce those qualities in the stupid greyhound, which we find in the intelligent and docile water-spaniel. Some species have an inherent tendency to produce these connate modifications of intelligence; but unless care is taken to preserve them free from foreign admixture, they soon become blended in the mass of average talent usually found in the species. Hence connate modifications of intellect may be either *original* or *transmitted*. The first stupid greyhound, as well as the first intelligent water-spaniel, might have been descended from a pair of average talent; and these qualities, which were *original* connate modifications when they first appeared, have become *transmitted* connate modifications in our present races.

But the changes which the mammalia are capable of undergoing are not confined solely to their intelligent powers. We see that their external forms are also modified, and that this sometimes happens to a degree so great, as to render it a matter of considerable difficulty to ascertain whether the animals, so altered by circumstances, belonged originally to the same or to different species. These changes are induced by causes which may affect the individual only, or they may also alter the offspring. The same law is observed in the changes of external form as in the modifications of intelligence and instinct; and while the individual varieties which are induced after birth are but rarely transmitted to posterity, the connate varieties give rise to most of those permanent alterations which distinguish the several races. "We see no instance of connate variety," observes Dr. Prichard, "however trifling, which does not manifest a tendency to become hereditary and permanent in the race. White animals with red eyes produce offspring resembling themselves, and the stock will retain its character permanently as long as no intermixture is suffered to take place. The progeny of black animals have the sable hue of their parents. On this account, black rams are always killed in this country, and never suffered to remain with the flocks. In other countries black sheep are preferred, and are bred up, while the white, when that variety springs up, are destroyed; accordingly, the general colour of the flocks is black. All the other varieties, as is well known, have a tendency to hereditary transmission. We may observe, that the disposition to variation is more frequently shown in some species than in others, and requires the agency of less powerful causes to excite it into action. The tendency to hereditary descent also is different, both among the animal and vegetable species. For in some species of the latter class, varieties are observed to reappear in the plants produced from the seed, and to continue constantly in the stock, resembling in this particular the nature of animal varieties. On the other hand, some species of animals approach to the capricious character of the vegetable kinds, and the variations which arise in them evince little tendency to become permanent."

It may be proper to recall to memory the definition of the term *species*. All animals are said to be of the same species, when they are descended one from another, or from common parents, or from others resembling them as much as they resemble each other. On the other hand, all those differences which are found among animals, sprung from the same original stock, are termed *varieties*. The most superficial characters are always the most liable to variation:—The colour of the hair depends greatly on the quantity of the light,—the thickness of the fur upon the degree of heat,—the size and corpulence of the animal upon the quantity of food, jointly with the degrees of temperature and moisture. Often the variations of colour are wholly connate, and can be traced to no external cause. Among the wild animals, these variations are very much limited by the natural propensities of the animals themselves, as they never willingly ramble to a great distance from those localities where they find a convenient supply of all the things necessary for the maintenance of their species. Their migrations are therefore limited by the circumstances which unite all these conditions. Thus, the wolf and the fox inhabit every latitude from the frigid to the torrid zones, yet they scarcely undergo any alteration, through all the changes of climate, except a greater or less degree of beauty and richness in their fur. The variations are still less among those wild animals, especially carnassiers, which are confined within a small geographical range. A thicker mane forms the sole difference between the hyæna of Persia and that of Morocco. These variations would be confined within still narrower limits, if the wild animals were at liberty to choose their own localities. But from the earliest ages, they have been hunted by man, or by the more formidable carnassiers, and exiled from their native haunts. Some have been driven into unfavourable situations; those possessed of a sufficient flexibility of form have extended their range to remote distances, while the others were left no other retreat but the pathless deserts bordering on their native country. There are no species which, like man, have established themselves in every country. A great number are confined to the tropical parts of Asia and Africa, others solely to the warm districts of America. Some are seen only in the arctic regions; another animal world opens before the voyager towards the South pole. Many islands have their own peculiar creation; and even some chains of mountains and valleys are seen to abound with animals unknown to every other part of the globe. Among all these species, we find, when all other conditions remain the same, that those confined to a small district exhibit the smallest and least important variations. The herbivorous mammalia are much more liable to be influenced by climate than the carnassiers, because their food is more variable, both in quantity and quality. For this reason, the elephants in one forest will be larger than in another. Their tusks will be longer in those places where the food yields a greater quantity of the matter necessary to enter into the composition of ivory. The same thing will happen to the rein-deer, and to the stags, in respect to their horns. However, the nature of their food serves to confine the range of the herbivorous tribes within still narrower limits than that of the carnassiers. Thus the entire influence of the climate and food upon wild animals is by no means very great. Some variations are, however, due to another cause. When the same male always continues attached to the same female, as happens with the roe-bucks, the young exhibit that uniform resemblance to each other, and to the parents, which demonstrates the fidelity of their attachment. It is evident, that where the same female attaches herself to several males, as happens with the common hinds, *Cervus elaphus*, the varieties must be greatly increased. We must also expect to find considerable variations in those smaller species which are very productive. Females bearing five or six young ones at a birth, and producing perhaps three times a-year by different males, must greatly augment the number of these varieties.

Among the wild animals, any connate varieties which may arise from local causes, are soon blended by a continual intercourse with the original race, and in a few generations they wholly disappear. Hence we find in the herds of wild animals characters of marked uniformity, which cannot be discovered among those domestic races where the care of man has intervened, and rendered the varieties permanent. Nature has placed a fixed barrier to those variations, which might have arisen from the union of males and females of different species. We usually find that species, nearly allied to each other in zoological characters, bear a mutual aversion of the most marked and decisive kind. It requires the greatest degree of ingenuity and constraint, on the part of man, to deceive the animals so far as to form these unnatural unions between different species; and when the hybrids thence produced are themselves productive, which seldom happens, they do not continue so for many generations. Even this partial fecundity would not probably have existed, without the continuation of that care by which the first union had been induced. We never find in the woods any animals of a character intermediate to the hare and the rabbit, to the weasel and the polecat, or to the stag and the fallow-deer. There are, however, distinct species which are capable of producing by their union fertile individuals. The offspring of the dog or his female, with the female or male wolf or fox, are prolific. The same thing occurs with the offspring of the he-goat and ewe. The mules produced between the ass and mare are sometimes prolific, and fertile races may be produced from the unions of several birds of distinct species. Yet these are merely exceptions to the more general law, that the unions of animals of different species are either wholly unproductive, or the offspring is a hybrid, and incapable of procreation.

There is a tendency among most animals, whether wild or domesticated, to pass occasionally into white varieties, distinguished by the term Albinos. Their hair is remarkably soft, and perfectly white, the iris of the eye is of a bright red colour, and the sight is acutely sensible to light. These varieties are therefore crepuscular, that is, they appear only during twilight or moonshine. In dark woods, old cathedrals, and obscure subterranean retreats, the common brown mouse acquires, from the absence of light, the red eyes and white hair of the albino variety. This property becomes hereditary, and thus races may be formed, as has happened in the case of the common ferret, which is probably only a variety of the polecat, *Mustela putorius*. The offspring of two brown mice are white when the old animals are retained in absolute darkness. These albino varieties have also been seen in the Bactrian camel, the elephant, the beaver, and in a very great number of other animals. See the article ALBINO.

"By far the most powerful cause of the evolution of varieties in the Animal Kingdom," remarks Dr. Prichard, "is domestication. To be convinced of the truth of this fact, we need only look at the phenomena which surround us on every side. In all our stocks of domesticated animals, we see profuse and infinite variety, and in the races of wild animals, from which they originally descended, we find a uniform colour and figure for the most part to prevail. Domestication is to animals what cultivation is to vegetables, and the former probably differs from the natural state of the one class of beings in the same circumstances, which distinguish the latter from the natural condition of the other class. The most apparent of these is the abundant supply of the peculiar stimuli of each kind. Animals in a wild state procure a simple and unvaried food in precarious and deficient quantities, and are exposed to the inclemencies of the seasons. Their young are produced in similar circumstances to the state of seedlings which spring uncultivated in a poor soil. But in the improved state, all the stimuli of various food, of warmth, &c., are afforded in abundance, and the consequence is a luxuriant growth, the evolution of varieties, and the exhibition of all the perfections of which each species is capable." Hence it is in man and domestic animals that varieties are most numerous and perplexing. At present, we shall confine our remarks to the changes experienced by the domestic animals, leaving the more interesting and difficult consideration of the varieties in the human race to a more advanced stage of this work. Indeed, it is only after a careful study of the limits of variation amongst the domestic animals, that we shall be competent to consider the varieties of the human race in an unprejudiced and impartial manner. In those species which have experienced an imperfect domestication, the variation is but slight, and it is due chiefly to climate. Thus, we have but few varieties of the cat, and their modifications are by no means considerable. Some have a softer fur, the colours of others are perhaps more vivid, or their size is greater. These are the limits of their variations, and they are further confined by the habits of intercourse which the tame cats preserve with the wild individuals of their species, established in their immediate neighbourhood. In this way, all the tame cats bear a marked resemblance to the wild cat of pure breed. The colour of the latter is uniformly grey, with blackish longitudinal bands, while its fur is somewhat rough. When tamed, in some climates, its colours become vivid or the fur grows smooth; in other countries the colours are softened down and become blended together, and the fur grows rough. When the European cats are removed to the warmer parts of Africa, their form does not change with the climate. Their variations of colour prevail chiefly in Anatolia, Spain, and Persia, where distinct races have been formed. It is said, that there exists in China a variety of the domestic cat, with pendant ears, and in the Isle of Man there is a distinct race destitute of tails. These form the extreme limits of variation in a species, which serves to mark the transition from the wild to the domestic mammalia.

We may naturally expect to find a greater degree of variation in the domesticated herbivorous mammalia, which have been transported into every climate for our use, and to whom we allot various portions of food and labour. Their modifications are, however, merely superficial. A greater or less degree of size; longer or shorter horns, or the want of them altogether; or, perhaps, a lump of fat on the shoulder, or near the tail, are the general limits of their variations. The colour also is ever variable, and often without any assignable cause.

The goat has experienced many changes of colour, and in Spain it has lost its horns. The different qualities of fleece found in the Cashmere, Thibet, and Angora goats, are well known in commerce. It is, however, the last of these varieties, which appears, from its pendant ears, to have departed the most widely from the original type. The usual and well-known influence of the climate of Anatolia, joined to the long domestication of the species, in a nation civilized at an early period, has produced this variety by the long-continued action of these causes. Buffon remarked that the Angora goats born in France were losing those long and pendant ears which characterize the Syrian variety, and it was expected that in a few generations they would acquire ears and fleece resembling those of the common goats of that country; but, according to Blumenbach, the Angora variety continues permanent when the animals are removed to other climates.

Among the sheep, the variations are numerous, but these chiefly refer to the fleece, which it has been the constant care of man to alter and improve. In some districts the sheep are always black, and very often a white ram and ewe will produce a black lamb. In other places they may be brown, spotted, reddish, or even yellowish. These varieties of colour are still more accidental than the other differences, which arise among races from alterations of food and climate. The limit of variation among the sheep may be seen in those enormous accumulations of fat, which swell the tails of a race found in some parts of Africa and Asia. Pallas, who saw the sheep of the Kirguis, a tribe of Siberia, describes them as being more fat and deformed than any he had ever seen. They are taller than a young calf, very heavy, and somewhat resemble the Indian sheep in their proportions. Their heads are much swollen, with large pendant ears, and the lower lip extending far beyond the upper. The greater number have one or two bunches covered with hair, which hang down from their neck. In the place where in other sheep a tail is usually found, there is a round and large protuberance of fat, with scarcely any wool beneath, and these protuberances often weigh from thirty to forty pounds, and yield from twenty to thirty pounds of suet. These peculiarities continue permanent wherever they may be removed. The native sheep of Ethiopia are covered with coarse hair, and those of Thibet with very fine wool. The Ankon variety of sheep from Connecticut have the fore-legs bent like an elbow; and this deformity, which is usually communicated to their descendants, as well as the general shortness of all the legs, was at one time much cultivated, from the sheep being thence unable to climb the fences.

We have already seen, that the bull can scarcely be considered a domestic animal, when viewed in reference to its disposition; yet its colour varies equally with its more domesticated female. Innumerable varieties of the cow are distinguished by graziers; and France alone reckons at least sixteen varieties, deriving their names from the provinces which they inhabit. The possession of udders of enormous size, and the property of giving milk all the year round, are qualities acquired by domestication. We are informed by Pennant, that the American bison is covered in the winter with a long shaggy fleece, which hangs over his neck, and partakes somewhat of the nature of wool; but that in summer he is almost naked. In the island of Celebes there is found a variety of the buffalo, not larger than our common sheep.

The ass undergoes, from domestication, several changes in the colour and quality of its hair; but the wild asses, inhabiting the country of the Calmucks in immense numbers, resembling each other precisely in all those particulars which are observed to vary among the domesticated species. In other respects, they only differ from the domestic asses, in being of a greater size and beauty. The wild asses inhabiting the deserts of Barbary are uniformly grey, and are said even to outstrip the horse in speed of foot.

The joint influence of climate and domestication seems to have a greater power over the horse, and its varieties are accordingly almost infinite in number. In some the head is small and slender, the nostrils are wide and easily moved, the ears are slim and directed forwards, and the eyes are lively. In other varieties we have a complete contrast in all these particulars. The head is heavy, the nostrils are narrow and close, the ears are large and directed backwards, and the eyes have a marked expression of dulness. An equal degree of variety is found in their colours, which may be black, bay, brown, or white, or any combination of these shades. In Ceylon there is said to be a variety of the horse which is not more than thirty inches high; in other climates the horse is nearly as large as the Bactrian camel. In bulk it sometimes rivals the ox, and often it emulates the lightness of the stag. We are informed, by John Hunter, that all foals are usually of the same colour, and that, though the hair may vary as they become older, still the skin remains the same, being no darker in black than in white horses, which is contrary to what is observed in most species. There is an exception in cream-coloured horses, which have the skin of the same hue as the hair. In size, colour, and form, as well as the quality of the hair, they may differ greatly, but always within certain well-defined limits. We may perhaps consider the Calmuck variety, with very long, thick, and white hair, as the greatest deviation from the original type.

With the domestic hog, the extreme points of variation must be placed in its soft and pendant ears, the smallness of its tusks, and the union of its hoofs. This animal appears to depart most widely from its original form when domesticated in the warmest countries; and then the variations in size and shape are innumerable, and its colour usually changes to white. That variety of the hog with undivided hoofs, observed long ago by Aristotle, is sometimes found in England; and in Normandy there is said to be a race of hogs with the fore legs much shorter than the hinder.

It is, however, in the dogs that varieties are most striking and important. Man has transported these animals into every part of the globe, and the extent of his power is seen in the extraordinary differences of their forms. As their unions may be regulated entirely by the will of their master, and as the connate varieties of individuals are readily transmitted to their offspring, we find among them singular deviations from the original type. Not only is their colour infinitely various, but their hair becomes more or less abundant, and sometimes it is wanting altogether. The height of some dogs is five times as great as that of others, and their bulk may, therefore, be more than one hundred fold. These are not the only differences. They seem to be acutely susceptible to all those circumstances which affect the growth of the different parts of the body. The forms of their nose, ears, and tail; the relative height of their limbs; the progressive development of their brain; and the form of their skulls, are alike affected by these sources of variation. Sometimes the head is slim, the muzzle slender, and the forehead flat. Often the face is fore-shortened, and the forehead projects. Indeed, the differences between the French matin dog and the water-spaniel, between the greyhound and the bull-dog, are more strongly marked than those among many wild animals of the same genus, but of different species. It is unquestionably in the varieties of the dog that we see the highest degree of deviation yet ascertained to prevail among the individuals of any species throughout the entire Animal Kingdom.

Of all the characters which the domesticated animals possess, it may be observed that the colour of the hair and skin is the most liable to variation. Being placed externally, this part of the body is exposed more than any other to the influence of outward causes of change. The hair of the different dogs exhibits this natural versatility in a remarkable degree with respect to colour, quality, length, and arrangement. In cold climates the dogs have usually two kinds of hair; the one, being short, fine, and woolly, immediately covers the skin, while, in the other, the hairs are long and silky. It is the latter kind of hair which imparts the coloured appearance to the animal. In tropical climates, the fine and warm woolly hair becomes obliterated, and at length wholly disappears. The same thing happens in our houses, when dogs are protected from the changes of weather and the severity of winter. The skin of the Barbary dog is naked and oily; the bull-bog, the mastiff, the greyhound, and the carlin, have the hair short and smooth. It becomes longer in the shepherd-dog, the wild dog of New Holland, the French matin, and the Iceland dog; it is very long in the wolf-dog, the spaniels, and especially in the French bichon, where it sometimes reaches nearly to the ground. Again, if the hair be viewed in respect to its quality, we find at least as many shades of difference. The shepherd-dog, wolf-dog, and the griffon, have coarse hair, while in the French bichon, some water-spaniels, and the great dog of the Pyrenees, it is both silky and soft. In some it is straight and smooth, in others woolly and curly. Many races have the body clothed entirely with long hair, while on the head and limbs it is perfectly thin and smooth. Others, on the contrary, have the head and neck furnished with a mane, and the remainder of the body is covered with short hair. The wolf-dog is an instance of the former kind, and the lion-dog of the latter. In these respects, we find in the hair of dogs all those variations of quality and quantity which can be found in the several genera and species of the Mammalia. Their colours may be white, a deeper or paler brown, fawn, or black. Some dogs are seen entirely of one of these colours, but most frequently the tints are distributed irregularly in spots, which may be either large or small. Sometimes these spots have a tendency to become symmetrical; at other times the longer hairs are of a different colour from the short ones, and then the joint effect of the two colours produces different shades, according as the white, black, fawn, or brown predominates. Thus, we may see dogs with hair apparently resembling that of the wolf, and upon a closer examination this is found to proceed from the mixture of white, fawn, and black hairs; or more rarely the general effect may produce a grey slate colour. These colours are not connected with any particular variety, nor does it necessarily follow that dogs of different colours must be further distinguished by the forms of their heads, the quality of their hair, or the proportions of their bodies. It usually happens, in all these cases, that when care is taken always to unite individuals of the same colour, form, and size, that the race perpetuates itself. It is from the constant union of individuals having the same, or nearly the same, colour that the Danish dog, greyhound, bull-dog, and mastiff, are fawn, the shepherd-dogs are black, the wolf-dogs white, and the Gallic hound, the braques, bassets, and spaniels, have black spots upon a white ground; but when this precaution is not observed, the colours of the above-mentioned dogs will be modified in proportion to their degree of admixture with other races. However, the connate modifications of colour, as well as the more important ones of shape and size, usually end in becoming hereditary, when they are not counteracted by some neutralizing cause.

Thus we find, upon the whole, that the more important variations of the Mammalia may be ranged under the following heads:—

1. The skull and face may be shorter or longer, broader or higher; the forehead may be elevated as in the wild boar, or depressed as in the domestic hog. Thus, the head of the Neapolitan horse differs remarkably from that of Hungary and Transylvania, in the shortness and breadth of its lower jaw-bone. Camper also remarked, that the lachrymal depressions (*foveæ lachrymales*), which can be clearly observed in the wild bull, had disappeared by degeneration in the domestic ox.

2. The general figure and proportion of the limbs may be altered to a remarkable extent. We see striking instances of this variation on comparing the Syrian and Arabian horses with those of the North of Germany and the Shetland Isles.

3. In stature there may be a singular disparity; thus, the hogs transported to the Island of Cuba acquire a size nearly double that of the common European pig; and a very considerable growth takes place among the wild cattle of Paraguay.

4. The texture and quality of the hair may vary from the soft wool of the Thibet sheep to the dense and almost rigid hair of the Ethiopian variety. In Normandy, the bristles of the common pig lose all their stiffness. But the most singular instances of variation in the hair are effected by the climate of Anatolia, where this cause equally affects different species of Mammalia, and transforms the short fur of our cats and rabbits, as well as the wool of our sheep, into the long and silky fleece of the Angora varieties.

Lastly, the colour of the hair may vary from black to white through all the shades of brown or red. The fleeces of Angora often assume a silvery whiteness. Indeed, we have only to look around us to see innumerable instances of diversity in the colours of our domestic animals.

DOMICIL. The dwelling had peculiar privileges among the Romans; it was regarded as inviolable; for example, no debtor could be arrested in his domicil; no officer of the police or court could pass the threshold of a private house, to arrest even a person who did not dwell there. These rights and privileges still belong to the dwelling-house in England, the Netherlands, and the United States of America. The name *domicil* implies, in general, a place of residence; in a narrower sense, the place where one lives, in opposition to that where he only remains for a time.

DONAX. See ARUNDO.

DOOMSDAY BOOK. A very ancient record, made in the time of William the Conqueror, which now remains in the exchequer, and consists of two volumes. The greater contains a survey of all the lands in most of the counties in England, and the less comprehends some counties that were not at first surveyed. The Book of Doomsday was begun by five justices, assigned for that purpose, in each county, in the year 1081, and finished in 1086. It was of such authority, that the Conqueror himself submitted, in some cases wherein he was concerned, to be governed by it. Camden calls this book the *tax-book* of king William; and it was further called *Magna Rolla*. There is likewise a third book of Doomsday, made by command of the Conqueror; and also a fourth, being an abridgment of the other books.

DORMANT. See HYBERNATION.

DORONICUM. See LEOPARD'S-BANE.

DORSTENIA. A genus of curious plants, of the nettle family. Six species, all green-flowering, evergreen herbs, of less than a foot in height, have been introduced to the hothouses of Britain from the West Indies and tropical America; and nearly a dozen other species are known to botanists. The most interesting of the introduced species, a medicinal one, is noticed in the article CONTRAJERVA.

DORYANTHES. A gigantic, evergreen, herbaceous, ornamental plant, of the amaryllis family. It constitutes a genus of itself, and takes for its specific name *Excelsa*. It closely resembles the other amaryllideæ in habit and floral splendour, but enormously exceeds most of them in size, has a squamose or scaly stem, and propagates itself by shoots or suckers. It has the nearest resemblance to *Crinum amabile*, but is much larger than even that huge amaryllidea. It was introduced to Britain from Australia in 1800; but it has, in very few instances, been brought to flower; yet some specimens of it have suddenly rushed up to a height of 20 feet or upwards, and have hung out to the wondering gaze of man about 30 huge and gorgeous flowers each, and have had special accommodation provided for them in temporary erections, and have created a great and general sensation among florists, botanists, and the aristocrats of society. This extraordinary plant seems to succeed best in the atmosphere of ordinary orchideous houses.

DORYCNIUM. A genus of plants, of the clover division of the leguminous order. It has a near affinity to bird's-foot trefoil, and comprises several species which were formerly included in that genus. The subshrubby species, *Dorycnium suffruticosum*, formerly called *Lotus dorycnium* and *Lotus monspeliense*, was introduced to Britain from the south of Europe, about the middle of the 17th century. It has several weak, shrubby, freely-branching stems of from $1\frac{1}{2}$ foot to 3 feet in height; its leaves are few, small, hoary, five-lobed, and sessile; its flowers are small, white, and inconspicuous, and grow in small heads at the extremity of the branches, and appear in June and July; and its pods are short, and contain each two or three small round seeds. Seven or eight other species, all hardy, some herbaceous and some subshrubby, have been introduced to Britain, principally from the south of Europe; and several more are known to botanists.—Dorycnium is the specific name also of the pink-flowered convolvulus, popularly called rock-rose.

DOUGLASIA. A handsome little alpine plant, of the primrose family. It has brilliant-purple flowers, and blooms in April. It possesses a medium character between a primrose and an androsace. It was discovered, in 1827, on the Rocky Mountains of North America; and is quite hardy in the climate of Britain.

DOVE. See PIGEON.

DOWN. The softest underfeathers of birds, and the seminal and folial pubescence of plants. The seed-down of dandelions, thistles, and some other compositæ is familiar to almost all schoolboys, even to those of cities. Some vegetable down is sessile, and some is pedicled, some is simple, and some is branched.

DOWNS, DOWNLANDS, or WOLDS. Extensive hilly tracts of land, with very light and thin soils. They differ from moorlands, principally in being covered with grasses instead of heaths, and in having the materials of their soils in a comminuted or powdery condition. The downs of most characteristic features and of greatest extent are the large tracts of low chalky hills, called downs in the southern counties of England, and wolds in Yorkshire and in some other northern districts; and the downs of more doubtful character and of more limited extent, are some hilly tracts of the green-sand formation, some tracts of oolitic or of calcareous sandstone country, some patches or circumscribed tracts of the mountain limestone formation, and certain elevated and small districts of the killas or schistose formations. But all true downs, whatever be their substrata, have a thin, dry, light, porous, calcareous soil, and are comparatively cold in climate and elevated in situation; yet they necessarily comprise various degrees of both calcareousness and warmth,—some consisting wholly of chalk, and others having a predominance of fine sand, or a fair admixture of argillaceous matter,—some tracts rising into the bleakness and cold of naked mountains, and others descending into the shelter and warmth of hill-locked vale or cultivated plain.

Downs, in the loosest or original sense, are mere accumulations of sand-drift; and must be regarded as quite alluvial in character, and as the most fickle and fugitive of all geognostic formations. "The effects of the sea, without the co-operation of inland rivers," says Cuvier, "are less productive. When the coast is flat and the bottom is sandy, the waves drive the sand towards the shore; at each ebb; a portion is left dry, and the wind, which generally blows from the sea, casts it higher on the beach. Thus the downs are formed,—those sandy hills which, if the intervention of man does not teach him how to fix by introducing herbage suited to the soil, progress slowly but with certainty towards the interior of the country, and then overwhelm fields and dwellings, because the same winds which convey the sand of the beach on to the down, cast that of the summit of the down still farther inland. Wherever the industry of man has failed in confining them, these downs advance inland as irresistibly as the alluvial deposits of rivers advance towards the sea; they drive before them pools formed by the rain-water of the lands in their vicinity, whose progress towards the sea they intercept; and their advance in many places is made with alarming rapidity; forests, buildings, and cultivated fields are overwhelmed by them." Downs of this description exist along the west coast of the county of Donegal in Ireland, and have, within the memory of the present generation of men, made exactly such encroachments and desolations as Cuvier indicates; and downs of the same class, though on a comparatively small scale, and with very little power of accumulation and progress, exist on the coast of part of Ayrshire, part of Forfarshire, and parts of other maritime counties of Great Britain.

But downs, in the English sense of the word, and also in the agricultural sense of it, have neither the siliciousness, nor the travelling character, nor the utter barrenness of these sand-drifts from the sea; and may be viewed, in the aggregate, as light pastoral lands, naturally producing a sufficient herbage for the feeding of flocks, and thoroughly capable of being profitably converted into arable lands. The grasses which are indigenous upon them are generally scanty, and seldom luxuriant, yet almost always palatable and nutritive. Those most common on the thoroughly chalky soils are *Bromus erectus*, *Bromus pinnatus*, *Avena pratensis*, *Festuca ovina*, *Phleum pratense*, and *Phleum nodosum;* those most common upon an abundance or a predominance of siliceous matter, are *Agrostis stricta*, *Agrostis fascicularis*, *Agrostis vulgaris*, *Festuca pratensis*, *Festuca cambrica*, *Festuca rubra*, *Aira praecox*, *Poa compressa*, *Briza media*, *Avena pubescens*, and *Anthoxanthum odoratum;* and those most common upon a good intermixture of argillaceous matter, are *Lolium perenne*, *Poa pratensis*, *Dactylis glomerata*, *Festuca duriuscula*, *Avena flavescens*, and *Cynosurus cristatus*.

The downs of the southern counties of England are, in general, in a far inferior agricultural condition to the downs or wolds of the northern counties; and while the former continue to be characteristically pastoral, and very extensively unenclosed, the latter comprise large tracts of reclaimed and cultivated land, and not an inconsiderable proportion under constant arable rotation. Yet no creditable reason can be assigned for the difference. The downs of the south, as to both their intrinsic character and their relative position, are strictly similar to the wolds of the north; and why ought they to be inferior to them in agricultural condition? They have no poorer a soil while waste, and no hungrier a one when cultivated; they are quite as rich in substrata of excellent chalk, for the supply of the materials of surface improvement and permanent amelioration: they are quite as contiguous to good grass lands, the cattle from which, fed judiciously while consuming the straw, afford the advantage of excellent manure; and they quite as amply command an inland navigation and a railway communication for obtaining artificial manures from the sea-ports, and for sending their surplus produce to the market-towns. "Two districts, thus similar in their nature and resources, but so opposite in their mode of cultivation for the last half-century," remarked Mr. Pusey in 1843, "prove the many and great advantages of a good system of husbandry, and the much-to-be-regretted results of a bad one. The one country continues to increase in fertility; the other still remains in a state of comparative sterility. The northern district, from the port of Hull alone, encourages commerce to a large extent. The imports for 1841 amounted to 120,865 quarters of linseed, 77,380 quarters of rape-seed, 8,346 tons of oil-cake, 5,255 tons of rape-cake, and 25,908 tons of bones,—total value, £900,000. The southern district makes very little use of foreign productions for the improvement of its light poor soils; indeed, it is capable of promoting in but a very small degree the home trade of the kingdom, the labourers' wages being barely sufficient to provide them with food; whereas, under a well-conducted alternate system of agriculture, there always exists a well-paid and well-clad population, which cannot fail to cause a mutual reciprocity of good feeling between the agriculturists and manufacturers." See the article Bone-Manure.

The farmer of the southern downs may be averse to encounter the great cost of procuring artificial manures, the land-agent may be averse to assume additional troubles of supervision and management, and the landlord may be averse to incur the expenditure of erecting additional farm-buildings; yet all these classes, in the existing condition of the districts, are unquestionably inferior in wealth and comfort to the corresponding classes in the improved portions of the northern wolds. Almost any ordinary or average piece of down-land may be so manured and managed as to yield a profitable course of crops throughout an indefinite period from the time of its being broken up; and even a tilled piece which has been grossly mismanaged, or rapidly worked to exhaustion, may, under judicious and persevering treatment, be brought, in a few years, into a highly remunerating condition. "The farm I now occupy, on the highest part of Salisbury Plain," says Mr. Pusey, "was taken in 1832, on a ten years' lease, at 24s. per acre, rent and tithe. The first crop was wheat, which, I believe, exceeded 4 quarters per acre; the next oats, which I ascertained to be nearly 8 quarters per acre; then turnips, without manure, except one quarter per acre of bone-dust for the swedes. The occupier then left it, declaring that the land was exhausted, and would ruin any one to work out the lease. I ventured to undertake the farm for the remaining term; and for the first three years I certainly had the worst crops imaginable, —wheat and barley, little more than the seed again,—oats, about 4 quarters per acre, under 30 lbs. per bushel; grass seeds would not grow, the land was so light,—indeed, such clouds of dust frequently blew from the land, that sheep could not pasture near it. The improving state of the farm from the turnip system and the artificial grasses, is now apparent; seven quarters per acre of oats are easily attained, and of good quality. The present rent and tithe, though too high for the times, is 18s. per acre, at least four times its original value." The grand means of profitably farming all down-lands which are converted into tillage, as well as of fertilizing such as have been scourged to exhaustion, are to manure with bones, chalk, and farm-yard manure, and to practise the following five years rotation,—first, turnips or rape,—second, barley or oats,—third and fourth, grass seeds fed green,—and fifth, wheat. Yet the manures must be apportioned with judgment and special adaptation; and the rotation must be occasionally varied, or, in some instances, may be permanently modified. Mr. Pusey reports concerning the occupier of a stronger and better piece of down-land than that on which he had himself experimented: "He has boned his land to a very considerable extent; and his turnips, thus managed, have invariably been a great crop. It is his opinion, that were the system of two corn-crops in succession, and of mowing the seeds for hay instead of pasturing with sheep, done away with, the land would become more certain for turnips, particularly swedes, than in the north. He has also grown linseed with success; for which he considers the lightest of the downs particularly adapted. He thus obtains a substitute for oil-cake, the carriage on which from London renders it very dear. Linseed is sown, instead of barley or oats, in the spring. He has brought into cultivation the whole of his own down-pasture, and is enabled, by artificial grasses, to keep more sheep in summer, and much better than in its original state. But his greatest advantage is in the winter; a good turnip system, in lieu of hay, enabling him to provide food for many more sheep at a far less cost, as well as keeping them in a much higher state of condition. In short, the farm will bear comparison with the rich land of the neighbourhood, considered of twice the value."—*Communications to the Board of Agriculture.—Sinclair's Hortus Gramineus Woburnensis.—Quarterly Journal of Agriculture.—Journal of the Royal Agricultural Society of England.*

DRABA. A genus of beautiful, low-growing, alpine plants, of the cruciferous order. All have either white or yellow flowers; most have a height of only about two or three inches; a few bloom early in spring, but the greater number about midsummer; a few are annuals or biennials, but most are evergreen, herbaceous perennials. Four species are natives of the mountains of respectively Wales, Scotland, England, and Ireland; upwards of 30 species have been introduced from foreign countries, principally Switzerland, Siberia, and the north of Europe; and about 30 other species are known to botanists. One of the earliest known of the exotic species is described as follows by Miller, and may serve as a specimen of the whole genus: "It grows naturally on the Alps and other mountainous parts of Europe. This is a very low plant, which divides into small heads like some sorts of houseleek; and from thence it was titled *Sedum alpinum* or alpine houseleek. The leaves are short, narrow, and very hairy; from each of these heads comes out a naked flower-stalk an inch and a half high, terminated by loose spikes of flowers, having four obtuse petals placed in form of a cross. When these fade, they are succeeded by triangular or heart-shaped pods, which are compressed, and enclose three or four roundish seeds."—Draba is also the specific name of a hardy annual, of the pepperwort genus.

DRACÆNA. A genus of tender, evergreen, ornamental shrubs and trees, of the asphodel family. About 20 species have been introduced to the hothouses and conservatories of Britain, from India, China, Mauritius, Madagascar, Sierra Leone, Cape of Good Hope, and Australasia. Nearly all carry white flowers; and about a third of these have mature heights of from 10 to 35 feet, while the remainder vary in height from 2 to 8 feet. The common or dragon species, *D. draco*, is a native of India, of about 10 or 12 feet in height, and has been known in Britain since before the middle of the 17th century. But both the most elegant and the most curious species, is the terminally-flowering, *D. terminalis*, introduced from the South Sea Islands in 1820. This species grows about 10 or 12 feet high, carries white flowers in March, has a general appearance similar to that of a palm, and is at once one of the greatest arborescent beauties of our stoves, and one of the most valuable plants of its native country. Its rootstock is fusiform, large, and woody; and affords to the Polynesians materials of both food and drink. The rootstock, when newly dug up, is yellowish-white, hard, fibrous, and almost insipid; but, when baked, it is yellowish-brown, soft, agreeably sweet, and exceedingly rich in strong saccharine juice. Part of the baked rootstock is eaten as food; and part—the greater part—is used for the manufacture of beer and distilled spirit. The leaves of the plant are excellent provender for cattle, very durable thatch for the roofs and sides of houses, and admirable material for temporary tents and shades; and they were formerly woven together by their stalks into a sort of short cloaks, and worn by the natives in their mountainous journeys. The whole plant is frequently grown in lines as a strong and durable hedge; and, in former times, a branch of it was always an emblem of peace, and, together with the plantain-tree, a succedaneum for a flag of truce. Most of the species of dracæna are propagable from cuttings; but a few require division of the root.

DRACOCEPHALUM. See Dragon's-Head.

DRACONTIUM. See Dragon.

DRAG. A contrivance for checking or regulating the motion of a wheeled vehicle upon a declivity. Drags of a very diversified construction, both for carts and for carriages, are familiar to the most ordinary observer, and need not be described. One of the simplest for carts is Kneebone's,—consisting of a piece of wrought iron so formed as exactly to fit the curvature of the wheel, with a chain to keep it steady, and to be fastened to the near shaft; and this implement is so hung on hooks at the under part of the tail of the cart as to be always ready for use. "This simple contrivance," remarks Smith, "has never failed to be effectual in retarding carts, or any two-wheeled carriages, while descending hills, taking off the great burden from the shaft horse, and permitting the carriage to descend with the greatest ease and safety in the most mountainous country. It may be applied to any kind of road, and is not subject to the inconvenience of locking-poles, which, on rough roads, among loose stones or deep ruts, are very apt to overturn carts by the sudden resistance they meet with. Deep ruts or loose stones have not been found to lessen the advantages of this drag."

DRAG. A very heavy pair of harrows. But the word is thus used only in some districts.

DRAGON,—botanically *Dracontium*. A genus of curious, evergreen, creeping, tropical plants, of the order aroideæ. Two species, the many-leaved and the prickly, each apetalous and about two feet high, were introduced to the hothouses of Britain, from respectively India and Ceylon, a little after the middle of last century; and several other species are known to botanists. The root of the many-leaved species, after having been artificially freed from some of its acrimony, is used in India as an antispasmodic, and as a remedy for piles and for asthmatic affections; and, as sold in the bazaars, it has an odour similar to that of musk, but not nearly so strong.—Dragon is also the popular name of two hardy perennial-rooted aroideæ of the arum genus, *A. dracunculus* and *A. dracontium*,—the former sometimes called common dragon, and the latter green dragon.

DRAGON'S HEAD,—botanically *Dracocephalum*. A genus of ornamental plants, of the lip-flowered order. Between 20 and 30 species have been introduced to British gardens; and several more are known to botanists. Five of the introduced species are hardy annuals, with blue, white, and purple flowers; two are half-tender winter occupants of the conservatory; and the rest are hardy, herbaceous, deciduous perennials. One of the earliest known of the herbaceous perennials grows wild in the woods and on the river-banks of North America. Its stem is erect, quadrangular, and about 3 feet high; its leaves are opposite, sometimes ternate, sessile, lanceolate, serrate, and about 3 inches long and half an inch broad; and its flowers grow in long spikes on the top of the stems, have a purple or dark red colour, and bloom from July till September. One of the half-tender species, and probably the most interesting specimen of the genus, is described in the article Balm of Gilead.

DRAGON-TREE. See Dracæna.

DRAINING. The withdrawal of superfluous or injurious moisture from land, by means of artificial conduits. It draws off water either along the surface, or in connexion with springs, or through the subsoil; and hence, though exceedingly various in kind, it is capable of classification into surface-draining, strata-draining, and subsoil-draining. It is the most powerful of the several processes for reclaiming waste lands, and for improving stiff soils; it is not exceeded by either tillage or manuring in its beneficial influence upon the richest description of arable lands; and it is equal or superior to all other georgical operations whatever, in the great diversity of its modes of action, direct and indirect, in producing and maintaining fertility. Weather has scarcely a more intimate relation to climate, than proper draining has to efficient agriculture. The principles of draining, therefore, ought to be thoroughly understood; its practices ought never to be conducted in either a random, a blindfold, or a prejudiced manner; and all discussions of its nature and utility ought to be unencumbered by theory, and have reference solely to science and facts. The worst of the multitudinous systems of draining which have challenged public notice deserve some examination; and the best have not adaptation to all lands and districts, and are scarcely beyond the reach of criticism for any. We shall do our best, on this great subject, to be at once clear, comprehensive, and impartial; and in order that every reader may be enabled to form his own opinion of the uses of draining, and of the particular modes of it which may seem best adapted to any given varieties of land, we shall commence by giving a somewhat full view of the principles on which it acts, and of the effects which it produces.

The Principles and Effects of Draining.—A superabundance of water on the surface of bogs, fens, and marshes is so obvious a cause of great and manifold evils as not to require explanation; yet it operates, in many respects, quite as leniently as an excess of moisture in the cultivated lands of peopled districts. "The water which is retained under the soil on impervious layers of earth," remarks a writer in the Quarterly Journal of Agriculture, "effects incalculable mischief. While hidden water remains, manure, whether putrescent or caustic, can impart no fertility to the soil; the plough, the harrow, and even the roller, cannot pulverize it into a fine mould; the grass can contain no nutriment for live-stock, as the finer sorts disappear, and their places are usurped by coarse aquatic plants; the stock can never receive a hearty meal of grass or straw from land in such a state; they are always hungry and dissatisfied, and of course remain in low condition; the trees acquire a hard bark, stiffened branches, and soon become the prey of innumerable parasites; the roads in the neighbourhood are constantly soft and rutted; the ditches and furrows are either plashy or like a sponge full of water,—suitable receptacles for the newt and the frog; the circumambient air is always damp and chilly, and from early autumn to late in spring, the raw hoar-frost meets the face like a wet cloth morning and evening; in winter, the frost incrusts every furrow and plant with ice, not strong enough to bear one's weight, but just weak enough to give way at every step, while the snow lies lurking in crevices behind the sun till late in spring,—fit feeding-ground of the woodcock and snipe: and in summer, musquitoes, green flies, midges, gnats, and gadflies torment the cattle, the labourer, and his horses from morning to night, whilst the sheep get scalded heads and eaten up by maggots during the hot blinks of sunshine." Yet dismal and horrible as is this catalogue of evils, it does not point at one half of the principles on which draining operates, or name one half of the calamities which it conquers or repels.

The excessive humidity of our climate, particularly throughout all Ireland and the western parts of Scotland and England, might suggest the probability of draining being as requisite for the corn-fields of our country as irrigation is for the rice-fields of the tropics. An excess of either moisture or drought is seen by all observers to injure most cultivated crops; and an excess of humidity in one set of climates, corresponding to an excess of aridity in another set, might seem to the most unreflecting mind to be a provision of the all-wise and all-beneficent Creator to provoke man to the exercise of forethought, prudence, and healthful manual labour. Farmers cannot control the clouds of either a dry climate or a wet one; but they can, with comparative ease, supplement the former's deficient supplies of rains by irrigation, and draw off the latter's excessive supplies by draining. "It is the nature of the climate, then, that regulates the necessity for draining: and as the humid seasons greatly outnumber the dry ones in this country, we must therefore adopt that necessity. Had our climate been like that of Italy, not only no draining would have been in general necessary, but our rivers, like hers, would have been directed into channels to irrigate our lands, in order to preserve to them that pleasant verdure in the height of summer, on which the eye gazes with so much delight, amid the rich luxuriance and the plains of Lombardy."

Plants of different species have wide differences of constitution for relishing or disliking moisture, as well as for enduring extremes of heat and cold; and, with very few exceptions, such plants as agree with much moisture contain exceedingly little of the elements of nutrition for either man or beast. Thorough succulent aquatics, such as can thrive in the presence of constant surface water, are chiefly sphagnums, hypnums, algæ, cotton-grasses, and other cryptogams and worthless phænogams, fitted only to accumulate themselves into the substance of bogs, fens, and morasses; and the less decided aquatics, or such as thrive only above subsoil water or with but the occasional presence of surface water, are chiefly rushes, sedges, coarse bents, and other tall and bulky herbage, large-rooted and usurping enough to prevent the growth of fine grasses, and consisting principally of elements and secretions which the stomach of no domestic animal can digest. The draining of morasses, therefore, brings them into a condition for producing land plants; the draining of wet grass lands disposes them to exchange their coarse herbage for the finer grasses; and the draining of corn-fields deters them from giving a coarse aquatic character to their produce, and enables them to bear their crops in the manner of superior fertility. "On drained land," remarks Mr. Stephens, "the straw of white crops shoots up steadily from a vigorous braird, strong, long, and at the same time so stiff as not to be easily lodged with wind or rain. The grain is plump, large, bright-coloured, and thin-skinned. The crop ripens uniformly, is bulky and prolific, more quickly won for stacking in harvest, more easily thrashed, winnowed, and cleaned, and produces fewer small and light grains. The straw also makes better fodder for live stock. Clover, in such land, becomes rank, long, and juicy, and the flowers are large and of bright colour. The hay from it wons easily, and weighs heavy to its bulk. Pasture-grass shoots out in every direction, covering the ground with a thick sward, and produces fat and milk of the finest quality. Turnips become large, plump, as if fully grown, juicy, and with a smooth and oily skin. Potatoes push out long and strong stems, with enlarged tubers, having skins easily peeled off, and a mealy substance when boiled."

Both soils and subsoils have wide differences of capacity for moisture, so that a degree of humidity of climate which is eminently fertilizing to one kind of land may produce a great excess of moisture upon another. Humus, clay, and chalk readily absorb moisture to the degree of saturation; and when they are presented with more than a saturating dose of it, they retain it as if they were vast beds of minute sponges, and as completely prevent its percolation as if they were strata of tallow or of metal; while silicious sands and gravels, on the other hand, can receive none of it into their granules, and allow it to percolate amongst them with all the freedom of a rapid and constant filtration. Soils of humus, clay, or chalk, therefore, if not freed from an enormous proportion of water by drainage, will necessarily produce nothing but aquatic plants in climates which naturally enrich and fertilize arenaceous soils; and substrata of clay or chalk, especially substrata so high as to sustain the relation of immediate subsoils, if not constantly tapped and fissured by the action of drains, will so arrest the descent of the water of prolonged or heavy rains as to cause the repletion and drowning of even sandy surfaces. The composition and structure of the earth's crust, also—the great number of its materials, their diversity, their mixture, their differences of mechanical condition, their geognostic relations, the disturbed connexions of alluviums and rocks, of strata and crystalline protrusions—occasion amazing differences and sudden transitions of retentiveness and porosity, rendering one place thirsty and insatiable, and another spouty and disgorging, and sometimes producing as great and unconquerable a necessity for artificial drainage on the farm as for natural drainage at the sources of rivers. But we reserve a full view of the saturating of land from springs and subterranean stagnations to the sections on respectively strata-draining and subsoil-draining.

The natural or artificial stagnation of considerable bodies of water frequently occasions, not only the loss to cultivation of the extent of surface which the water covers, but a very mischievous excess of moisture in circumjacent cultivated land. Lakes and ponds, in many instances, are so shallow and cover such beds of rich alluvium, that the draining of them is one of the cheapest and easiest possible methods of obtaining an accession of good land; and even some lakes and ponds which are deep, and which cover rocky, gravelly, or otherwise barren bottoms, are, in some instances, the causes of such wide-spread wetness and spoutiness of both soils and subsoils, that the draining of them is well repaid by the permanent drying of the surrounding lands. The water of ditches which surround fields, also, particularly of such as extend along the highest side of the fields, often finds its way downward into the porous parts of the subsoil, oozes up to some parts of the surface of the fields, and effects, in wet weather, as great and mischievous discharges and plashiness as the out-bursting water of a strong perennial spring. The water of dams, large surface drains, and small confined rivulets, whenever flowing along a higher level than that of adjacent fields and meadows, is likewise a frequent cause of considerable local wetness of land; and may be pointed out as a species of drainage which itself requires draining, and as illustrating the necessity of maintaining all sources of water, whether natural or artificial, at a lower level than the proper seat and aliment of plants in the adjacent lands.

The drying of land by draining produces a most powerful effect upon the food of cattle, exterminating noxious aquatic plants, improving the quality of the finer grasses, vastly increasing the amount of nourishment, and occasioning an agreeable dryness and a palatable flavour in both roots and leaves. Grass lands which were formerly wet, poached, and rushy, become thickly carpeted with fine nutritious grasses, maintain a greatly increased number of sheep and cattle, prevent the sheep from being attacked with rot, render the cattle good-tempered and kindly, and occasion the flesh of both sheep and cattle to be greatly improved in points and flavour. "In the southern districts of Scotland, particularly in the counties of Berwick, Roxburgh, Selkirk, and Peebles," said Sir John Sinclair in 1817, "most of the principal sheep farms have been very much drained, and the consequence is, that the size, quality, and healthiness of the stock in these districts have been thereby so much improved as appears almost incredible to those who were acquainted with the former state of sheep-farming in those parts. In many of these farms, the rent has increased fourfold, and the rot is now hardly known." Even the stiffest and most retentive clay lands, such as, with slight or imperfect draining, would be thoroughly poached by cattle, and would bring a pestilence of rot upon sheep, may, by a process of complete subsoil-draining, be rendered excellent turnip soils, perfectly healthy for all live stock, and capable of being folded or fed off by sheep in either summer or winter.

The texture of wet land multiplies the labours of tillage, and is vastly improved in its workable capacities by draining. Its texture, even though everywhere consisting of the same materials, is exceedingly and fitfully various in hardness and softness. Some portions of it are spongy with the springing or the percolating of water; some are consolidated by the successive expulsion of moisture, tread of cattle, and drying by evaporation; some are tough with the matted and elastic roots of carices and semiaquatic grasses; some are stubborn and refractory with the firm imbedding of small stones; and some present a rapid succession of depths and shallows of soil, ready at one moment to fling up the plough to the surface, and at another to tempt it down to a perilous and impracticable depth. A ploughman, in working such land, must practise the utmost steadiness of eye and skill of hand; he is kept on a constant tension of vigilance and effort; he is worn with exertion, tantalized in his efforts, vexed and plagued in temper, put to a severe and constant trial of all his powers as a ploughman and all his patience as a man; and even though he should be one of the ablest, most experienced, most persevering, and best-tempered operatives of his class, he will utterly fail to maintain uniformity of depth in the furrow-slice, or to effect regularity or tolerable goodness in general execution. His plough will dip in some places, and be tilted up in others; it will now be arrested and now let go, so as to make a succession of violent strains and jerks upon the horses; and it will, in few places, lay the furrow-slices completely over, or so effectually detach their lower edges from the basement-soil as to make their npturned sides cohere in the manner of a continuous mass. The harrows, too, will rather scratch the tops of the furrow-slices, than tear their whole body into powder; and the roller will effect such a compression as to render the surface somewhat like that of a footpath. But when even the wettest and most clayey arable land is completely drained, it acquires a free, friable, homogeneous texture, as sweetly and facilely workable as that of a naturally light arenaceous soil. "Being all alike dry, its texture becomes uniform; and being so, the plough passes through it with an uniform freedom; and where ordinary-sized stones obstruct its course, the plough can easily dislodge them. The plough by its own gravity tends to raise a deep furrow; and the furrow on its part, though heavy, crumbles down and yields to the pressure of the mouldboard, forming a friable, mellow, rich-looking mould, not unlike the granular texture of raw sugar. The harrows, instead of being held back and starting forward, swim smoothly along, raking the soil into a smooth uniform surface, entirely obliterating the prints of footmarks. The roller compresses the surface of the soil, and leaves what is below in a soft state for the expansion of the roots of plants."

But the draining of wet land, besides facilitating and improving the labours of tillage, greatly abridges their amount, and economizes their cost. The operations are easier, and therefore require fewer horses; and they are far more efficient, and therefore require less repetition. "I should say," remarks Mr. Arkell, in his recent Prize Essay on draining,—and his experience closely coincides with that of all clay-land farmers who have adopted a good system of subsoil-draining, —"I should say my land, which is more heavy in ploughing than might be thought from its appearance, ploughs as easily now with three horses as it formerly did with four; and as there are no wet furrows to encourage grass and weeds, the summer fallow is no longer necessary, which will somewhat lessen the number of ploughings. And when we also consider its ploughing up mellower, its requiring less dragging and harrowing to get it to a tilth, also no furrows or trenches to be ploughed out after the seed is sown, and likewise that you are often able to plough it from the land being dry, when otherwise you could not or ought not,—taking the above heads together, I should say there would be saved one-third of horse-labour, though some will say that the saving is a great deal more, provided the land is only kept as clean as before, but I would rather understate than overstate any thing." Some portion of the saving of horse-labour, indeed, will require to be expended in the new direction of cartage from increase of crops; but this is a consequence which every farmer will very cordially welcome.

The draining of wet arable soil occasions a great aggregate increase in the productive area of fields. The laying up of ploughed lands in ridges is, in fact, a method of draining; but except on fields of the most unctuous and comminuted clay, which require a system of surface-draining in co-operation with a system of subsoil-draining, it is a method no less rude and wasteful than ancient and general; it throws off an excess of water from the crown of the ridge, at the expense of producing an accumulated excess in the furrow; it requires the ridges to be narrow or the furrows to be numerous in proportion to the very tenacity or fructiferous powers of the soil; and it occasions the stripes of land which constitute the bottoms of the furrows to be almost absolutely barren, and the stripes which constitute the flanks of the furrows or the borders of the ridges to be only semi-productive. A glance at the utterly bare furrow-bottoms and at the thin and dwarfed produce of the furrow-flanks, as compared with the tall and luxuriant corn of the summits of the ridges, incidentally illustrates the vastly fertilizing power of drainage, and will probably suggest that about one-twelfth or one-tenth of the entire area of ridge-and-furrow fields is unproductive to the farmer.* Now in consequence of the drying effects of good subsoil-draining upon every part, every square foot, of a field, and upon all the parts of it alike, the whole of this great area, the one-twelfth or one-tenth of the surface of all his cropped lands, is saved by subsoil draining to the farmer.

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* "Superficial drainage," remarks Mr. Parkes, "is comparatively of little value, and is, perhaps, exemplified in its worst practical form by land tortured on the ridge and furrow system. When land is permanently cultivated in high ridges, the crowns can obtain but partial benefit from the action of rain. The gradation from the comparative dryness and warmth of the summit, to the suffocating wetness and coldness of the furrows, is commonly evidenced by the state of the crops grown on land so disposed. It would be curious, but possibly more curious than useful, to learn the origin of this remarkable artificial configuration given to land, which is, I fancy, peculiar to England and to particular counties. One would think that this system must have been invented previous to the discovery that water would find its way into cut drains; or the inventor may have considered rain as his greatest enemy, and that

Even on subsoil-drained lands which still require to be laid up in ridges, such as unctuous clays upon retentive subsoils, some saving of productive area can be effected by means of a mode of ridging which cannot be practised on undrained or even on partially but imperfectly drained land. "After I have drained a piece of land," says an experienced georgist in reference to land of this description, "if I wish to keep it in ridges, which I do when the lands are wide and on a clay subsoil, I plough each land alternately ridge and cast, always ploughing the two lands that lie to be ridged first, one on each side of the one to be cast. By doing so, I have only one finishing furrow to two lands, and that always on the top of the ridge, and they are generally plain enough to hoe or to reap without fresh striking. By this mode, there is no more treading over the drain than over any other part, and a considerable amount in manual labour is saved annually in not having to make furrows and water-trenches, which are quite requisite before the land is drained, though, besides taking off the water, a considerable portion of the best soil is washed off with it."

The loss of rich soil and prime manure by surface currents on undrained retentive land is very great. The portions of soil most thoroughly pulverized, those which possess the highest intermixtures of ammonia, potash, and other food of plants, and those which have been worked by chemical action into a state of the greatest fitness for the immediate uses of the growth of plants, are precisely the portions which the rains sweep away; and the amount of them on all kinds of undrained retentive land is so great as to render the streams into which they are carried exceedingly turbid; while the amount on fields which are laid up in high and narrow ridges is sometimes so enormous as to render the little rills of drainage almost like thin paste. The manure swept away, too, is the very best on the land,—either absolutely liquid manure, holding in solution the largest possible proportions of ammonia,—or solid organic manure in the last stages of eremacausis, almost ready to assume the aeriform condition, and quite ready, in a great degree, to be absorbed and assimilated by the plants; and though the quantity washed away cannot be accurately estimated, it must in all cases be very considerable, and in some so great as nearly to exceed belief. On pasture lands, also, the loss is enormous. Not only are some portions of the manure deposited by the flocks washed away piecemeal by successive heavy rains during the pasturing season, but a large proportion remains to be swept off by the deluging rains of winter. Much of the manure from the summer's depasturing is still on the surface of the land in autumn; and though portions of it continue to sink into the soil till the latter becomes saturated, yet almost all which remains after the point of saturation is swept away. Now thorough draining, in all instances, prevents by far the greater part of this very serious loss to both ploughed lands and grass lands; and whenever the draining, the soil, and the weather, are such as to coax into the drains the whole of the superfluous waters discharged by the atmosphere, every particle of the loss is prevented.

The draining of wet wheat lands occasions a considerable saving in seed, and secures great regularity and fulness in germination and growth. On undrained clay soils, many seeds of wheat, especially in any unusually wet season, burst and perish; some young plants are starved, dwarfed, and eventually destroyed by stagnations of cold moisture; and some, in consequence of the swelling and shrinking of the parts of the soil from excess of damp, are thrown out of the ground and killed by alternations of frost and thaw. Draining may occasion the saving of two pecks of seed per acre, and prevent the loss of from one-twentieth to one-twelfth of the whole crop from the destruction of seed and of young plants.

Draining prevents the injurious effects of the stagnation of water. It does not, of course, and cannot, diminish the quantity of water which soils receive from the atmosphere; but, besides rapidly drawing off excessive supplies of it, and averting some most mischievous effects which an excess of it produces upon climate, soil, and vegetation, it prevents a malign chemical transmutation of its own properties from stagnation. The running water of streams is, in general, free from the excrementitious refuse of plants, and charged with carbonic acid, saline solutions, and comminuted alluvium; and it, in consequence, acts beneficially, for some time at least, upon fine and nutritious herbage, and occasions all the rich and luxuriant vegetation which is well known to characterize irrigated meadows. Even water which wells up in the form of springs from the bowels of the land is, in numerous instances, so highly charged with carbonic acid and saline matters as to act nutriently upon many fine and useful land-plants; and, generally, when it has an opposite effect, and produces the same kind of mischief as arises from an excess of surface water, it really ceases to be proper spring water, and is converted by the local peculiarities of soil and level into water of saturation. But stagnant water, whether from rain, from canals, from pent-up streams, or from repressed and smothered springs, is, in all instances, destitute of the carbonic acid and the alkaline mixtures which

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he ought to prevent its entrance into the soil, and get rid of it as soon as possible."

LANDSCAPE GARDENING

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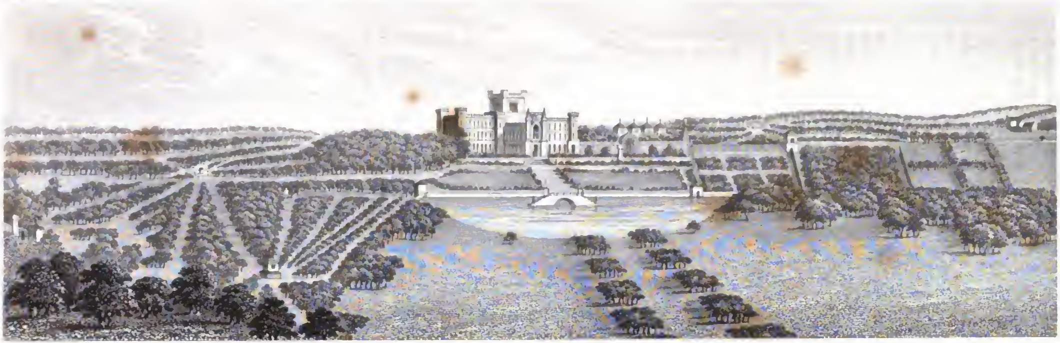

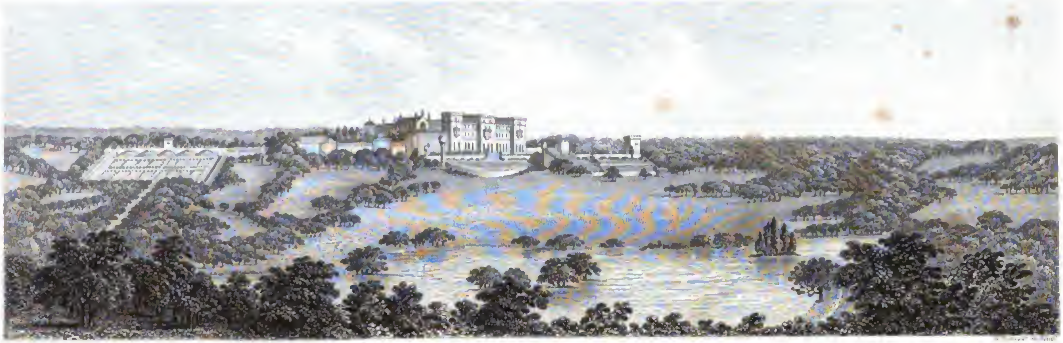

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nourish vegetation, and more or less charged with vegetable excrementitious matter which is injurious to cultivated crops. No horizontal current passes across a collection of it to carry off its solutions of vegetable excrement, or to spread it out in a succession of surfaces for aeration; but, on the contrary, a slow ascending current rises vertically through it, occasioned by evaporation from the surface,—a subordinate descending current falls perpendicularly downward, occasioned by a lower temperature below than above; and the consequence is that the roots of plants immersed in it, instead of being fed with aqueous solutions of all the valuable gases of the atmosphere, are steeped and sometimes almost drowned in a liquid which presents them with scarcely a particle of nourishment, and which is drugged and polluted with accumulations of vegetable excrement. All stagnant water, no matter how limpid, possesses more or less of the disgusting insipidity which indicates the absence of carbonic acid; and very many specimens of it possess a foulness of both taste and colour which indicates unwholesomeness of condition. If draining, therefore, did no more than prevent the stagnation of water around the roots of plants,—did it merely maintain such a current or circulation in water as should keep it in a fresh condition,—it would exert a great and benign influence upon the vegetation of the farm. All this is true respecting stagnation in its mildest forms or initial stages; and as to stagnation in fens, morasses, and vegetating ponds and ditches, the draining of it amounts to the averting of fevers and pestilences from man and all the domestic animals, and of death and extermination from almost all kinds of vegetables except the lowest species of aquatic cryptogams.

The draining of wet land greatly raises the average spring and summer temperature of the soil, produces an effect upon the early ripening of hardy crops, and upon the hardiness and vigour of half-tender plants equal to what would result from cultivating them a number of degrees nearer the equator; or, in some instances, it occasions so great an increase of genial warmth as practically to convert a drained field of Britain into a field of strictly kindred powers to those of an undrained field of the same composition, exposure, and elevation, in the south of France or the north of Italy.—Evaporation is the only means by which the stagnating and the saturating waters of undrained land can escape; and at whatever temperature this takes place, whether high or low, it consumes, in the susception of every pound of water as great a quantity of heat as can be evolved from the combustion of nearly 2¼ ounces of coals. Suppose the aggregate fall of rain on an acre of land to amount in a year to the depth of 30 inches, and suppose only the one-half of it to be dispersed from that acre by evaporation, the total quantity evaporated throughout the year would be 54,450 cubic feet or 1,519 tons, and this would amount on the average to 4·16 tons per day, and would absorb and carry off a quantity of heat equal to all which could be obtained from the daily combustion of about 12 cwts. of coals. Now all this enormous quantity of heat is either actually extracted from the soil on which the evaporating water lies, or is intercepted from the sun's rays, and prevented from entering the soil by the process of evaporation; so that the whole of it is truly and absolutely lost for the purposes of vegetation. The depression of terrestrial temperature consequent on evaporation, or on the want of drainage, is thus so great as almost to confound vulgar belief; and this depression must, in every instance, be proportionate to the degree in which the water of stagnation or the water of saturation exceeds the quantity of circulating water requisite for vegetation. "Soils in that state must necessarily be very cold in the spring months, and much colder at the time of the commencement of vegetation, and throughout the summer, than well-drained or naturally drier lands. If we knew the capacity for heat of any given soil, and the weight of water mixed with it in excess, over the proper complement necessary for vegetation, it would be easy to determine, very nearly, the depression of temperature caused by its evaporation. We know that the heat of a pound of water in its gaseous state, that is, as steam, would raise the temperature of about 1,000 lbs. of water one degree; so that if the specific heats of the solid and the fluid bodies were alike, the evaporation of a pound of water would keep down the temperature of 1,000 lbs. of earth one degree, of 500 lbs. two degrees, and so on."—But water also throws back into the atmosphere by radiation a vast quantity of heat, which, but for its presence, would be received and retained by the soil. Water has been abundantly proved to be one of the most powerful radiators of heat, or one of the most rapidly cooling substances, with which we are acquainted; and during frost, steaming water will acquire a coat of ice sooner than water cold from the well, and boiling water thrown on the ground will freeze sooner than cold water. A wet surface, therefore, is altogether incapable of enjoying, for any considerable time, a genial heat in even the finest and warmest weather; for, in addition to the enormous amount which it wastes in evaporation, it possesses but for a brief period the richest acquisitions of it from sunshine till they become dissipated and lost by radiation.—Nor is this all. Stagnant water is one of the very worst conductors of heat, and, in consequence, seriously obstructs the absorption of heat from the sun's rays by the subjacent soil; and it also acquires a slight increase of weight from the loss of heat by evaporation and radiation, and, in consequence, maintains within itself a constant series of displacements of its warmer atoms from below by the descent of its cooled atoms from above. The stratum of it which occupies its surface, in the cool of the evening, or at a fall of temperature during the day, cools, becomes heavier by cooling, and immediately descends; and this film of cooled and condensed water is immediately replaced by warmer and lighter portions, which speedily form another film; and thus stratum after stratum cools, condenses, and descends, each giving off a portion of its heat by radiation, and forcing upward a body of atoms warmer than itself, until, in extreme circumstances, the whole mass of water attains its maximum density, or has sunk to the low temperature of 42°.—By all these methods, then, evaporation, radiation, non-conduction, and increase of density, the water of stagnation—as well as in a large degree also the water of saturation—exerts a constant and enormous refrigerating influence upon soil. "On the other hand, when a soil is naturally so porous, or is brought into such condition by art, that rain-water can sink down into the earth, it becomes a carrier, an alert purveyor, instead of a robber of heat; and tends to raise permanently the temperature of the mass of useful soil; and this more particularly and beneficially during the vegetative season. Rain-water, at that time, conveys downwards the more elevated superficial heat of the soil, and imparts it to the subsoil in its course to the drains; it leaves the soil in a fit state to receive fresh doses of rain, dew, and air, and in a better condition to absorb and retain heat, at the same time that it promotes, in other ways, its fertility and productiveness."

A curious fact, one of the numerous apparent paradoxes which often delight scientific inquirers, is, that the draining of wet land acts beneficially by depressing the temperature of the soil in winter, just as truly as by elevating it in spring and summer. Stagnant water, as has been already hinted, attains its maximum density at 42° Fahrenheit; so that all decrease of temperature below that point can occur only at its surface, and, even when sinking to 32° and under, will affect only the surface by either expansion or congelation, and cannot penetrate through the body of the water, and still less to the soil on which it lies. This curious law is exemplified not only in sheets of water, or in strict water of stagnation, but also in all such water of mere saturation as truly occupies the interstices among the particles of the soil. Perennial-rooted plants upon wet land, therefore, stand throughout the winter in a minimum heat of about 41°; they are never allowed to settle down into the dormancy or hybernating repose which is requisite for the recruiting of their organic powers; they continue, during the severest and most prolonged frosts, to live and fritter away their strength in a semi-active condition; and when spring shakes them thoroughly up, and summer evokes them to discharge all their functions, they prove to be jaded, feeble, and sickly, and are unable to bring forth more than a fraction of their normal amount of produce. But on dry and porous land, whether naturally dry or dried by draining, the temperature of the soil cools down to the point of obtaining protection from snow, and perennial-rooted plants enjoy a long and a fast sleep throughout the winter, and then they start up in spring with the energy of renovated strength and reinvigorated being.

Draining acts beneficially on the roots of plants, increasing their range for feeding, aiding the healthiness of their absorption, and preventing injury from their excrementition. The roots of plants, by a most beautiful provision of the Creator, grow only by increment at the ends; and when stiff soils are rendered porous and dry by draining, the roots are coaxed out in all directions, both horizontal and perpendicular,—the rapid formation of spongioles or feeding orifices is induced,—both the bulk and the ramifications of the entire root are greatly increased,—and, when the plants die, the roots remain and decay in the soil, adding to its depth, and resolving themselves into accumulated humus for feeding their successors.—Absorption through the spongioles, indeed, might seem, on first thought, to be benefited by excess of water, and is known in all instances to require some degree of moisture, as well as seen in many to be carried on during constant immersion of the roots in mere water; but, except in aquatic cryptogams and other marsh plants, it requires a continual and large supply of oxygen for the preparation or maceration of its food in the soil,—it presupposes circulation of moisture no less than successional supplies of food,—and hence, when the soil is drowned with either stagnant or saturating water, the food of land plants is both ill-macerated and excessively diluted, and the absorption of it becomes slow and sickly, and is followed by more or less of vegetable atrophy.—The law of radical growth by increment at the ends, not only pushes out the spongioles in search of fresh food, but also carries them away from the deposition of excrement. "Now," says Dr. Madden, "when there is an excess of water in soil, all the soluble matter must be continually descending on account of the greater specific gravity of the solution; and consequently, the prevailing direction of the roots of plants growing in marshy ground should be perpendicular, as this is the direction in which the greatest supply of food will be obtained. Now, I rather think that observation will prove the correctness of this remark; at least, I know well that many marsh plants have a horizontal underground stem or rhizoma from which the rootlets proceed directly downwards. If, however, the roots of plants descend, it follows that the excretion of to-day will be relatively nearer the surface than the spongioles of to-morrow; and consequently, if an excess of water be present, all excretions of plants being at first soluble in water, it will follow that the excrementitious matter will become immediately mingled with the food, and applied directly to the spongiole. If this observation be correct, it should be found that marshy plants are not so easily injured by the absorption of excrementitious matters as those growing in drier situations, which may probably be accounted for by the greater quantity of fluid at all times circulating through them." The draining of wet arable land, therefore, by rendering the soil porous, and preventing saturation with water, both enables the rootlets to escape laterally from the excrementitious deposits, and hinders these deposits from being held in solution and from settling down to the perpendicular rootlets in the manner of sediment.

The draining of land which has either a stiff or a porous soil incumbent on impervious substrata, provides a reservoir or comparatively ample supply of oxygenated moisture or of fresh water during the prevalence of droughts. The subsoil, whatever be its character, regulates the supply of moisture. When excessively porous, it occasions the superincumbent soil to be parched and arid; when spongy, it imparts to the soil such a capacity of saturation as renders it fit only for aquatics; and when impervious, it occasions surface stagnation during the prevalence of wet weather, and total exsiccation after a continuance of drought. But a subsoil of such porosity as to act like a filter, promotes both the easy descent of water during rains and the free ascent of vapour during droughts; it lets both the water of rains and the heat of droughts readily down to the subterranean channels, and in consequence maintains the precise kind of circulation which the changing conditions of the soil and the weather require; it permits excess of water from either springs or surface to pass away without injury to vegetation, and, at the same time, maintains a sufficient supply of water within range of the roots of plants, or at least within range of evaporation amongst them, to keep them from being withered or starved during even the driest seasons. Both the mechanical and the chemical action of drainage, also, act favourably on the maintenance of moisture. "It might be supposed that a soil improved by subsoil draining," remarks Mr. Shier, "would be more liable to suffer during protracted drought than an undrained one. This, however, is not the case; the plants being found fresh and vigorous, while those of a cold, compact, and undrained soil are burnt up. This arises from several causes,—the improved texture and absorbent power, the greater depth and feeding surface afforded to the roots, and the facility with which water adheres in a state fit for nourishing the roots. When the excess of water gets readily down into the drains, that which adheres contains carbonic acid, oxygen, ammonia, and other necessary and alimentary substances; while the stagnant water of undrained soils is prejudicial, by excluding air, by keeping injurious dissolved substances in contact with the roots, and by the cold incident to excess of moisture."

But we must distinguish between currents of water at a proper depth within or beneath a porous subsoil, and a body of stagnant or of saturating water along the bosom of an impervious subsoil; for the latter sends up noxious moisture into the soil by capillary attraction,—it sustains the same relation to the farmer's fields which abhorred "bottom water" sustains to the flower-pots and flower-beds of gardeners and florists,—and the necessity or at least great advantage of dissipating it is one of several very cogent reasons for preferring deep draining to shallow draining in all lands which have retentive subsoils. Some persons, indeed, question the existence of such an agency as capillary attraction through the minute interstices of land, and deny that either soil or subsoil is expanded by water rising from below; but if they will pour a little water into the pan of a common flower-pot, filled with moderately dry soil, they will observe it to be drawn speedily up into the soil,—and if they will fill two flower-pots with moderately wet soil, and put some water into the pan of the one but no water into the pan of the other, they will observe the soil of the watered pot to remain plump and full, and the soil of the unwatered pot to contract, and to leave a crevice between its own exterior and the sides of the pot. Now either stagnant or saturant water taken up by capillary attraction wants both the heat and the gases which are requisite to vegetation; and the carrying it off by means of deep drains practically amounts to the withdrawal of dead and innutritious moisture from the soil.

Draining acts powerfully, and in a great diversity of ways, upon the chemical condition of the soil. Some of the many chemical effects have not yet been investigated; others are intimately connected with the maceration of the food of plants; and others are intimately connected with the action and affinities of multitudinous manures. See the articles FOOD, MANURES, SOILS, and AGRICULTURAL CHEMISTRY. Only a very few, which either are general, or relate to the saline constituents of soil, or have connexion with lime or with farm-yard manure, need here be selected for brief notice.—The free access of air and of rain water through the pores of the soil occasions steady and normal decomposition of both organic and mineral substances, and maintains a regular and constant process of transmutation for macerating them into food absorbable by the spongioles. Oxygen is essential to all the decompositions which occur, whether in porous soil or under saturation; and the effects which result from oxygen freely and profusely supplied from the air, are widely dissimilar to those which result from sparse and reluctant supplies of it as a constituent of water. When oxygen rushes down from the atmosphere, it, in many ways, economizes both the organic and the inorganic substances for the use of plants,—and, in particular, combines with the carbon of humus to afford a constant supply of carbonic acid; but when, as in all saturated soil, oxygen is obtained by decomposing substances wholly or chiefly from water, the hydrogen which was in combination with it is set free,—and whenever it does not find a profusion of putrescent animal matter to supply it with nitrogen for forming ammonia, it rushes into combination with the carbon of humus, and in consequence diverts a considerable portion of the food of plants into the useless or noxious form of carburetted hydrogen. A piece of sheep-skin putrefied under water becomes leaden blue, gives off a fetid and very ammoniacal smell, and, when boiled in the water of its putrefaction, is unaffected by tincture of galls, but throws down a considerable precipitate with protomuriate of tin; and another piece of the same skin, putrefied in the same temperature, but kept merely moist and in contact with the atmosphere, suffers no change of colour, gives off a disagreeably pungent smell, as if acetic acid were present, and, when boiled in water, throws down a precipitate with tincture of galls, but is very slightly if at all affected by protomuriate of tin. This instance of putrefied sheep-skin was ascertained by experiment of Dr. Madden; and though it fails to show the precise results of either case of decomposition, it very distinctly proves that decomposition of animal matter under the action of air and mere moisture evolves very different principles from decomposition of the same animal matter under an immersion or saturation of water.

The chemical effects of draining upon the saline ingredients of soil may be illustrated by two select instances. Carbonate of lime and muriate of soda, which exist in very many kinds of soil, do not act upon each other under excess of moisture, but mutually interchange their elements under slight or moderate moisture, so as to produce muriate of lime and carbonate of soda. Both of the latter salts are valuable to soil,—the muriate of lime by increasing the soil's capacity of absorption, and the carbonate of lime by increasing the solubility of its organic constituents. In most cases, in consequence of the soil being comparatively dry when the phenomenon occurs, the carbonate of soda, immediately on being formed, escapes from further chemical action by effervescence; but both it and the muriate of lime are soluable in water; and when, in any circumstances, they afterwards meet each other in solution, they re-interchange their elements, and resolve themselves into the original form of carbonate of lime and muriate of soda.—The sulphate of lime or gypsum exists in most fertile soils, and the gaseous and very valuable carbonate of ammonia is constantly eliminated from the conjoint decomposition of vegetable and animal matters in the soil; and when these two substances are within range of each other in moderately moist soil, they interchange elements and form sulphate of ammonia and carbonate of lime. "Now this change is of great consequence. Let us suppose, for instance, that, from a want of proper mixture of the manure with the soil, so much manure is in one spot —which must occur for the first year or so of each rotation in drill husbandry—that the quantity of ammonia given off is more than one-half per cent. of the soil around it. Should nothing prevent it, the excess of this valuable ingredient would escape into the air. If, however, sulphate of lime were present, the alkali, which would have become carbonate by union with the carbonic acid always existing in soil, would immediately be absorbed; and, provided the soil were not too wet, the change above alluded to would occur, and sulphate of ammonia be formed, which, being perfectly fixed, will remain any length of time without being dissipated or lost. When, however, by the occurrence of a good shower of rain, the sulphate of ammonia is dissolved, and thus brought in contact with the carbonate of lime, the opposite change gradually occurs, and carbonate of ammonia and sulphate of lime are reproduced."—Thus in the case of both of the sets of salts which we have named, changes are produced in moderately moist or properly drained soil, not only of a kind important to vegetation and to the economizing of the food of plants, but of a nature diametrically opposite to such as take place in the presence of an excess of water.

The effect of draining upon both the chemical and the mechanical action of caustic lime is great. Lime naturally decomposes and converts into the food of plants many varieties of dead vegetable matter which, but for its action, would lie inert in the soil; but it requires a free circulation of air through the interstices of the soil and among its own particles, in order to its exerting its power; and, when dispersed throughout a soil which is saturated with moisture, it loses its causticity, and becomes as worthless and almost as deleterious as drowned chalk. Lime naturally acts also with mechanical effect, separating the particles of adhesive soil, and drying and pulverizing hard and cloddy clay; but it can produce this effect only in the absence of all excess or saturation of moisture; and if applied to clays in a wet and saturated condition, it would convert them into a kind of mortar, and would occasion them to become almost as hard as pavement during droughts. Even when lime is spread as a top-dressing upon grass-land, it can produce its well known beneficial effect only if the land be either naturally dry or artificially drained. Many ploughed fields, in either a naturally or an artificially dry condition, contain such an excess of vegetable matter as to want sufficient cohesion or consistency for giving mechanical support to plants; and when they are such free filtrators as never to become stagnantly saturated with rains, they derive from lime the great additional advantage of having part of their soft and incoherent substance converted into a supporting pabulum; but this advantage, as truly as the previous ones, cannot be obtained on any land which is excessively wet; for there the little masses of soft organic matter are soaked with water like sponges, and the lime lies incoherently beside them like lumps and particles of saturated chalk.

The effect of draining upon farm-yard manure amounts, in all instances, to the opportune and regular decomposition of the manure, and, in some, to the economizing of a large proportion of its nutrient principles. In wet land, the pulpy portions of the manure are taken up by the water, and deposited low in the soil as sediment, and the strawy portions are saturated with water and resist decomposition,—so that, during spring and early summer, very little food is furnished to the young plants by the manure; and when prolonged heat eventually carries off the excess of moisture, the plants are overfed in the upper part of the soil by the sudden decomposition of the straw, and overfed in the lower part of the soil by the manurial sediment which their roots are then able to reach,—and, at a late period of the season, they rush rapidly up to maturity, with such a surfeiting of their sap-vessels as is little less diseased or mischievous than their starvation and languor in spring. The result is the same whether the manure be spread through the whole soil or deposited in drills; yet, in consequence of the latter method disposing the manure in larger masses, and offering much less facility for the separation of the pulpy portions from the strawy portions, the effect is less malign in drills than in dispersion. "As an instance in point, potatoes cannot be successfully raised on wet land, when the manure is spread broadcast on the ground in autumn or early in spring. Before such practice can succeed, the land must be in heart. But even in drills, on wet land, the manure will be decomposed in different degrees and at different times. The driest portion of the soil will first and most effectually decompose the manure; the hardest, next in degree and time; and the wettest will retain it in a state of maceration, as long as the water is unevaporated by drought. Besides manure remaining inert in wet land, it also remains inert in such land rendered dry by drought. In that predicament, the manure becomes desiccated, undecomposed, and easily separated from the soil, which becomes like a sterile powder, and remains so until the return of rain. Were the rain to fall in moderate quantities, the decomposition of the manure would be rapidly hastened in the warm soil; but if, in inordinate quantities, its decomposition would be retarded as effectually as by the drought, although in this case it would be dissipated before decomposition. Nothing can so convincingly prove the benefits of draining in immediately securing the fertility of manure to the soil, than in contemplating the baneful effects of too much drought or moisture on manure. And to render the proof the stronger, we have only to contrast these effects with the effect of drained land on manure. The moment that manure is deposited in a proper state, that is in a state of humidity in drained land, its juices are absorbed by the dry soil, and retained there as in a wet sponge half squeezed. The strawy portion being thus deprived of moisture by absorption, and still surrounded with comparatively dry soil, which retains heat within itself, and readily absorbs more from the air, it is readily decomposed, and soon becomes intimately blended with the soil. Food in a semi-moist state is thus placed near and ready prepared for the tender spongioles of plants to exist upon; and supposing the weather no better, but only the same as in a case of manure deposited in undrained land, the progress of vegetation will completely outstrip that in the latter."

Draining promotes the healthiness and the vigorous growth of plants by lessening the humidity of the lower regions of the atmosphere. The coldness of wet lands condenses the aqueous contents of the immediately incumbent atmosphere into vapours so thick as sometimes to be visible, and the dissipation of their excess of water chiefly by evaporation produces almost constant accumulations of aeriform humidity over their surface; so that, from these two causes, wet lands are overhung by an enormously larger amount of humidity than lands which are dry. Now this excess of humidity dwarfs and deteriorates land plants at once by lessening their absorption of carbonic acid, by decreasing their evaporation of the useless portions of their sap, and by diminishing the number of their stomata or organs of communication with the atmosphere. The absorption of carbonic acid through the stomata of leaves is the principal function for the supply of carbon,—the bulkiest and heaviest of all the constituent elements of all land plants; absorption takes in this gaseous substance from the atmosphere, to subject it to chemical change within the walls of minute subcuticular cells; and whenever the stomata are clogged or the cells are filled with moisture from depositions of finely divided vapour upon the leaves, the process of absorption is, for a time, either encumbered or altogether arrested. But through the same stomata, the leaves of healthy plants require to throw out into the atmosphere about two-thirds of all the crude sap which ascends from the roots, and a still larger proportion in the case of land plants growing on wet soil; the evaporation of this proportion of the sap is essential to the elaboration of the remainder into cambium; and whenever the stomata are wholly or partially closed by atmospheric depositions of humidity, the process of evaporation is just as truly impeded as that of absorption. And when the clogging of the stomata by humidity is either frequent or prolonged, the plants begin to accommodate themselves to the circumstances in which they grow, and gradually close up or extinguish stoma after stoma till the total number of their stomata becomes greatly diminished, and their very power of absorption and evaporation becomes correspondingly decreased. Now draining removes the cause of these serious evils, and, in consequence, removes the evils themselves.

But the removal of excessive humidity from the immediately incumbent atmosphere, conjointly with the increase of heat in both air and soil which results from draining, prevents also a large proportion of the injuries which accrue to the crops of wet lands from hoar-frost. "The hurtful effect of rime or hoar-frost on vegetation," observes Mr. Black, in his account of the draining of the estate of Spottiswoode in Berwickshire, "is a circumstance familiar to all who have had experience of cold and elevated districts, or of lower lands subject to exhalations, or excluded from the influence of the sun and currents of air. The frost-rime, in the swampy hollows of the estate of Spottiswoode, was found, even in the warmest seasons, to be productive of serious inconvenience and injury to the growing crops,—and that chiefly at the period when the grain was approaching to its maturer state. This evil, it may be said, has been removed, or at least is now so little felt that the grain produced in these very hollows has, for many years, escaped the smallest perceptible injury from this cause. Indeed, any one who will look along a moist and swampy surface, when the frost-rime prevails, will see the vast and beneficial effects to the climate around, of the removal of so obvious a source of injury. No one can mistake the proximate cause of the phenomenon itself, since the rime will be seen to hang over every swampy place, and to follow the turns of every rivulet and marshy tract." Yet, during winter, hoar-froast is a decided benefit, rather than an evil, and protects the leaves of clover, brassicas, and other winter-standing plants from suffering a lower depression of temperature than 32° of Fahrenheit, exactly as a carpeting of snow protects the soil; and the season in which hoar-frost does injury is that of the maturing of annual crops,—both depriving them of the dews which it congeals, and subjecting them to a mischievous degree of cold. When the humidity of the lower strata of the atmosphere is occasioned either by the condensation and descent of the vapour of the clouds or by the evaporation of the water of rills, rivers, and lakes, and when it exists in a region and over lands of sufficient warmth to avert all risk of frost, it constitutes the most refreshing and fertilizing kind of moisture which vegetation can obtain, and resolves itself, during summer and autumn, into "the dews of heaven," so grateful and so reviving in almost every cultivated region of the globe.

Now draining aids vegetation by occasioning a great increase in the deposition of dews. Dry, porous, and thoroughly pulverulent soils radiate heat from a vastly greater number of points than wet or compact soils, and in consequence receive more abundant depositions of dew in comparatively high temperatures, and continue to receive some at such low temperatures as prevent the wet and compact soils from receiving any. Sands are powerful attractors of dew, and, in some countries, depend almost wholly upon it for the support of vegetation. The sandy plains of Chili rarely receive any rain, and might seem, from their position, to be closely akin to the extensive sandy deserts of Africa; yet, in consequence of their profuse radiation of heat by day, and of their receiving wondrous depositions of dew during the splendid nights of their climate, they maintain a comparatively high fertility. Even some sandy spots in Africa, which are never refreshed by either springs, rains, or artificial supplies of water, possess a flourishing growth of trees; while soils of some cohesiveness in the same latitude, and not far distant, require to be irrigated in order to their sustaining vegetable life. The low meadows on the banks of streams in Britain owe a considerable portion of their superior productiveness to copious depositions of dew, the volumes of air immediately over the streams receiving a profusion of humidity from evaporation, the wind and cold dispersing and condensing this humidity by night, and the finely divided and filamentous structure of the meadow-grasses peculiarly fitting them for drinking up the dewy globules. Nor is the benefit from the dew confined to the superficial layers of the soil. "If a soil be sufficiently permeable by air, and not saturated with water, it is in a state to receive accessions of moisture from the atmosphere, which is a constant and inexhaustible vehicle of humidity; and if the temperature of a sufficiently porous subsoil be at or below the dew-point, as will frequently be the case during some portion of the day in the summer season, the process of depositing dew will take place in the interior parts of the soil during the day, at the same time that the exterior or surface of the ground may be projecting both heat and moisture into the atmosphere. This process is evidently dependent on the relative temperatures and degrees of aqueous repletion of the air and subsoil at a given time, and independent of the hygrometric power of the latter, which is, however, a potent auxiliary to the acquisition and retention of atmospheric moisture by soil, particularly in its interior parts."

Draining has a powerful effect on the salubriousness of climate; and though this consideration does not directly affect the soil, it touches the farmer in the very sensitive points of the life and healthiness of all his live-stock and all his human dependants. Draining is the chief georgical improvement or agricultural operation which bears immediately upon health; but it exerts so mighty a power as to convert regions of red-hot pestilence to both man and beast into regions of eminent healthfulness, and of almost total freedom from epizootics and epidemics. Nor does it produce its salubrious effects, merely upon a great scale, when practised throughout a kingdom or an extensive region, but also upon a small scale, when practised in a parish or throughout any particular swamp. The signal instances of its great power in former times and in modern days, in foreign countries and in hundreds of British districts, are so numerous as to be incapable of reduction into any one general statement. The parochial reports in the Statistical Account of Scotland strongly connect the effects of drainage with the improvement of the general health, in almost every county and in very many parishes; and Mr. Chadwick's Report to the Poor-law Commissioners of England, says, "The importance of a general land drainage is developed by the inquiries as to the causes of the prevalent diseases, to be of a magnitude of which no conception had been formed at the commencement of the investigation,—its importance is manifested by the severe consequences of its neglect in every part of the country, as well as by its advantages in the increasing salubrity and productiveness wherever the drainage has been skilful and effectual." A single instance, of a kind not more remarkable than hundreds of others, may be quoted for illustration: "No locality, I believe, has been for some years so exempt from fevers of a malignant and contagious character as the eastern coast of Kent. Accordingly, idiopathic fever, under the form of synochus and typhus, very rarely occurs, and when it does appear, is generally of an isolated kind. Intermittents also, which 15 or 20 years since were so generally prevalent in this district, have become comparatively of rare occurrence, and indeed have almost disappeared from the catalogue of our local endemics. This exemption from ague and other febrile epidemics of an infectious nature may be justly imputed to the total absence of malaria, and of all those causes which usually generate an unwholesome and contaminating atmosphere, namely, from the whole district being secured from inundations by the most complete and effectual system of drainage and sewerage,—also, from the exposed state of the country favouring a free and rapid evaporation from the surface of the soil." Even in districts where little or no attention has been given to the statistics of human disease, the salubrious effects of drainage have been fully marked upon the lower animals; and thousands of rural observers cordially attest, in particular, how completely drainage has swept away some epizootics which used to be the scourge of sheep.

The prime *object* of all ordinary draining, as well as its prime *result*, is increase in the value of crops. *The amount* of this widely varies according to the intrinsic properties of the land, the judiciousness and economy of the draining, the particular method adopted, the cost of materials, and some other considerations. In not a few instances, in which either the land scarcely if at all required draining, or the method adopted has been unnecessarily costly, or the execution has been unskilful and ineffective, the increase of crops has been little or nothing; and in many others, owing to similar causes, it has by no means been great enough to compensate the operations. But even in the multitudinous cases of ordinarily good draining, the increased value of crops is very variously estimated, and seems to be very various in reality; and probably it is, in a great degree, controlled both by the intrinsic properties of the land and by the particular methods of draining. Land of naturally prime quality derives the highest degree of improved and prolonged fertility from draining; and any method of draining which effects the thorough and permanent drying of the land at the least possible amount of cost, necessarily yields a larger remuneration than methods which are either less efficient or more expensive. The best index of the profits of draining which, upon the whole, can be given, is contained in a few special examples and in one or two general estimates. A field of stiff clay which let in grass for 20s. per acre, was drained at the cost of £5 12s. per acre, and yielded wheat worth £11 per acre, and turnips worth £25 13s. per acre. A field, which was let at 12s. per acre, and overrun with rushes and furze, was drained at the cost of £5 9s. per acre, and then became worth 50s. per acre for grass, and yielded wheat worth £13 per acre, potatoes worth £15 15s. per acre, and turnips worth £21 per acre. An undrained half of a field yielded potatoes worth £13 per Scotch acre; while, in the same year, the other half of the same field in a thorough-drained condition, yielded potatoes worth £45 per Scotch acre. Lands amounting to 467 acres on the estate of Teddesley-Hay in Staffordshire were drained at the cost of £1,509, and rose in consequence from the annual value of £254 10s. to £689 13s., thus yielded an annual profit of 29 per cent. upon the cost of draining. Some moorland at Hutton-Bushel in the north of England, with shallow soil, two inches of moorband-pan, and a rubbly subsoil, was worth less per annum than 5s. per acre; but, merely by being drained to the extent of having its pan broken up with the subsoil plough, it immediately acquired the yearly value of a guinea per acre. A certain extent of undrained land in the north of Scotland, yielded 6 tons 4 cwt. of turnips per acre; and the same land, when drained, yielded 8 tons 8 cwt. of the same kind of turnips per acre. Mr. Howden of Wintonhill in Haddingtonshire estimates, from his own experience, that the thorough-draining of wet heavy land, even though it should cost so much as £7 per acre, will yield a profit, in the increased value of the crops, of from 15 to 20 per cent. on the expense of the operation. The beneficial effect upon grain crops is seldom realized, to any considerable degree, in the first grain season after draining, or till the drained ground has been fallowed, or has undergone a course of thorough working and of rotation-manuring; and it ought therefore to be estimated, both upon an average of years, and in conjunction with the average value of the inter-rotational green crops. Mr. Pusey, in an Essay on the Progress of Agricultural Knowledge, in the 3d vol. of the Royal Agricultural Society's Journal, states his belief that "five or six bushels of wheat per acre would be a fair estimate of the increase" of produce from the thorough-draining of wet land; but adds, with special allusion to the saving of surface from the abolition of the ridge and furrow system, that "the advantage of draining is not to be measured merely by the additional bushels of corn that may be grown on an acre." But a writer in the 40th No. of the Quarterly Journal of Agriculture, estimates the probable average increase in the produce of barley and oats from thorough-draining at 12 bushels per acre, and calculates that if all the arable land of Scotland were thorough-drained, the increase of yearly produce throughout that kingdom would comprise 420,000 quarters of barley and 1,912,500 quarters of oats,—an increase, on the assumption of 30s. per quarter for barley and 25s. per quarter for oats, worth upwards of three millions of pounds sterling,—and altogether exclusive of the corresponding increase in the value of wheat and of green crops, as well as of the great advantages to grass-lands, woods, live-stock, human health, and general economy.

The Ancient and Modern Practices of Draining.—The simpler methods of draining, or those of withdrawing water along the surface, appear to have been practised from very ancient periods of agricultural record. Cato, Palladius, Columella, and Pliny, all mention draining, and show themselves to have been acquainted with some of its most advantageous effects, and with various methods of constructing both open and covered drains; and Pliny, in particular, describes some methods of draining practised in his day, which were not long ago regarded by some of our nonclassical agriculturists as modern improvements. Many works of draining appear to have been executed by the Romans, or in imitation of their example, even in Britain. The inning of Romney marsh, the pattern of all our other reclaimed fens, is distinctly ascribed to the Romans; and the fosse-dyke in Lincoln, and many other ancient lodes and drains, were the work of their legions during the intervals of active war. Much labour in freeing the low grounds of England from liability to inundation, seems to have been performed also by the Frisian and Saxon colonists, from the watery flats of the north-west of Germany. The management of superficial draining, both in the formation of new works and in the repairing and maintaining of old ones, was well and abundantly sustained under the system of feudalism and petty jurisdictions,—more so, perhaps, than under the free and enlightened tenures of modern times. Commissioners of sewers, and special codes of drainage laws, very considerable in number, and extending down from a somewhat high antiquity, were instituted in England; and recitals of numerous enactments, with a particular account of the great national project for gaining the level of the fens in the eastern counties, may be seen in Dugdale's History of Embanking and Draining. But Scotland, in consequence partly of the great unevenness of its surface and partly of its very frequent political troubles, seems to have remained almost ignorant of drainage till the latter part of last century; and Ireland, notwithstanding the enormous extent of her quaking bogs and her inundated meadow-lands, knew nothing of any public commission of drainage till about 35 years ago, when a great and very effective commission was appointed to survey her bogs, and devise methods for their reclamation.

The necessity of draining so deep, whether by open or by covered drains, as to draw off bottom water, did not begin to be understood in Britain, nor perhaps in the world, till about the middle of the 17th century. A work was then written by Captain Walter Blith, which looked far in advance not only of his own age but of the following age, and which propounds the theory of the deep draining of swamps and meadows, with a clearness and a force fitted to instruct and almost to astonish multitudes of tolerably well-informed farmers of the present day; and though this work is so far-sighted and perspicacious, as distinctly to perceive the desirableness of the subsoil-draining of ploughed lands, it seems to imply that such draining was at that time totally unknown, and regards it as impracticable on account of "the incredible expense" which it would occasion, and recommends as a succedaneum the system of laying out the land in ridge and furrow. Captain Blith's work passed into a third edition in 1652; it is entitled 'The English Improver Improved, or the Survey of Husbandry Surveyed;' and it contains several prefaces, but is specially addressed to "The Right Honourable the Lord General Cromwell, and the Right Honourable the Lord President, and the rest of that most Honourable Society of the Council of State." In his instructions for forming the flooding and draining trenches of water meadows, the author says of the latter, "And for thy drayning trench, it must be made so deep that it goe to the bottom of the cold spewing moyst water, that feed the flagg and the rush; for the widenesse of it, use thine own liberty, but be sure to make it so wide as thou mayest goe to the bottom of it, which must be so low as any moysture lyeth, which moysture usually lyeth under the over and second swarth of the earth, in some gravel or swarth, or else, where some greater stones are mixt with clay, under which thou must goe half one spade's graft deep at least. Yea, suppose this corruption that feeds and nourisheth the rush or flagg should lie a yard or four foote deepe, to the bottom of it thou must goe, if ever thou wilt drain it to purpose, or make the utmost advantage of either floating or drayning, without which thy water cannot have its kindly operation; for though the water fatten naturally, yet still this coldnesse and moysture lies gnawing within, and not being taken clean away, it eates out what the water fattens; and so the goodnesse of the water is, as it were, riddled, screened, and strained out into the land, leaving the richnesse and the leanesse sliding away from it." In another place, he replies to the objectors of floating that it will breed the rush, the flag, and mareblab: "Only make thy drayning trenches deep enough and not too far of thy floating course, and I'le warrant it they drayn away that under moysture, fylth, and venom as aforesaid, that maintains them, and then believe me, or deny Scripture, which I hope thou darest not, as Bildad said unto Job, 'Can the rush grow without mire, or the flagg without water?' That interrogation plainly shewes that the rush cannot grow the water been taken from the root; for it is not the moystnesse upon the surface of the land, for then every shower should increase the rush, but it is that which lieth at the root, which, drained away at the bottom, leaves it naked and 'barren of relief.'" The author frequently returned to this charge, explaining over and over again the necessity of removing what we call bottom water, and which he well designates as filth and venom; observing, "I am forced to use repetitions of some things, because of the suitableness of the things to which they are applied; as also because of the slowness of the people's apprehension of them,—the which, wherever you are so draining and trenching, you shall rarely find few or none of them wrought at the bottom." As to the distance between the draining and floating, he prescribes no certain rule, saying—"If the land is sounder and drier, or lieth more descending, thou mayest let it (the water) run the broader; and as thy land is moyst, and, rushey, and levell, let it run the less breadth or compasse;" thus exhibiting a far more correct and intimate acquaintance with his subject than is often to be found among the water-meadow artificers of the present day. He gives a most just account of the cause of those boggy places and swamps so often formed on the slopes of hills, and at their foot, and describes the mode of treating them, so as to effect a perfect cure, which coincides with the best practice of the present day, always insisting on making deep excavations *into the eyes* of the springs, &c. For all drainage purposes, he reprehends shallow trenches, observing, in respect to bog-drainage, —"But for these common and many trenches, oft times crooked too, that men usually make in their boggy grounds, some one foot, some two, never having respect to the cause or matter that maketh the bog; I say, away with them as a great piece of folly, lost labour, and spoyle, which I desire as well to preserve the reader from, as to put him upon a profitable experiment. As to destroying the bog, it doeth just nothing, only taking away a little water which falls from the heavens, and weaken the bog nothing at all, and to the end it pretends is of no use." He, likewise, gives a good notice of covered drains; he describes them as more expensive than open drains, but as much more capacious and durable; and he recommends to be placed at the bottom of the trenches, "good green faggots, willow, alder, elme, or thorne," or in firmer stuff, "pebble stones or flint stones, and so fill up the bottom of thy trench about fifteen inches high, and take thy turf and plant it as aforesaid, the green soard downwards, being cut very fit for the trench, so as it may joyne close as it is layd down, and then having covered it all over with earth, and made it even as they do other ground, waite and expect a wonderful effect through the blessing of God." He prescribes also, in all cases excepting for water meadows, the driving the drains right up and down the fall of the land.—In this account of draining water meadows and swampy lands, one cannot but recognise very sound principles, and these are represented by Captain Blith as having been put into practice by himself, and copied by others, and as having raised the value and rent of land, from a few shillings, to two, three, and four pounds per acre.

Captain Blith's system of drainage was probably understood and very generally adopted within a limited district of country; and, but for the want of efficient means of making it known, it might have found advocates in the remotest parts of the kingdom, and might have greatly accelerated the progress of modern improvement. Its very principles, too, appear to have been appreciated, and carried out to their consequences; and a system of deep thorough-drainage, so perfect as almost to bear comparison with the best of the present day, appears to have, in the course of about a century after Captain Blith wrote, become known and practised throughout a main part of the large and well-farmed counties of Essex, Suffolk, Norfolk, and Hertford. This system, indeed, has always existed in great obscurity, and eventually became so limitedly and feebly known to British agriculturists that the recent revival or re-discovery of it by Mr. Smith of Deanston was almost universally regarded as a perfect novelty; yet it exists, in the present day, not only in monuments of past practice, but in continuous and routine usage from the time of its institution. Mr. Pusey, writing in 1842, or seven years after Mr. Smith of Deanston's system first became known in England, states that he had discovered that very system to have been long practised to its fullest extent in Suffolk, and that he had reason to believe that a system closely similar to it had long been practised in Essex, and was known even in Scotland under the name of the Essex system; and writing again in 1843, he adduces conclusive proof, that a true and efficient system of thorough-draining, such as bore close resemblance to Mr. Smith's system, and such as may be supposed to have arisen out of the application of Captain Blith's principles, had, for a century before, been practised, not only in Suffolk and in Essex, but also in Norfolk and in Hertford. "In proving that Mr. Smith's system is not new," says he, in the earlier of his two papers, "I do not lower his claims to our thanks, for he probably invented it also, and at all events carried it out with an energy which made it new in his hands. But I think the fact of its previous practice in Suffolk and Essex worth notice for two reasons;—one, that any new method, however highly recommended, must be received with doubt as long as it continues new, and that consequently the best praise by which any method can be recommended to practical farmers is, not that it is new, but on the contrary that it is old and tried. The other reason is this, that here was a plan of draining which was regarded as novel, yet had been employed and established for half a century at no great distance from London; and this is by no means a singular proof how little the farmers in one part of England knew, until lately, what the others were doing."

In 1764, while the system of subsoil-draining continued to be very limitedly known, and while very shallow and inefficient systems were generally prevalent, Mr. Joseph Elkington, a farmer in Warwickshire, accidentally discovered the system of strata-draining, and became the originator of a great and very general reform in the draining practices of Britain. He was plagued with a degree of land-wetness which rotted many of his sheep; and while he was digging a deep trench to serve some purpose of drainage, he forced a crow-bar 4 feet through the bottom of the trench with the view of ascertaining the nature of the strata, and, on pulling it out, was surprised to find it followed by a copious and permanent flow of water. He made an inference as to subterranean currents of water or the general nature of springs, and arrived at the doctrine that the draining of subsoils or substrata may be readily and thoroughly effected by tapping with an auger or a rod. His doctrine was worked into a system, put to the test of experiment, and rapidly promulgated among wondering and grateful agriculturists; and though it was speedily found to be altogether inapplicable to lands which consist to a great depth of absorbent earths, such modifications and extensions of it were invented and put into practice as rendered it a guide to under-draining beneath almost every kind of soil. The simplest form of Elkington's system continued to be mere tapping; and the most elaborated form of it became a ramification of main-drains, branch drains, and subordinate branch drains, somewhat similar in parts and connexions to the figure of a trained fruit-tree on a wall or an espalier. Mr. Elkington received from Parliament a reward of £1,000 for the service which his discovery conferred upon the kingdom; and his system was applauded by the Board of Agriculture, explained through the press by the eminent drainer Mr. John Johnstone, and practically recommended in Scotland by the well-known drainer Mr. Stephens. But though this system continued to confer great benefits upon Britain till about the year 1824, it is now almost everywhere superseded, at least on deep absorbent lands, by various systems which shall be afterwards mentioned, of deep subsoil-draining by means of parallel drains.

Lands which require Draining.—Ponds and lakes are, in a great many instances, profitable subjects of surface-draining, on account either of the marl or rich earth which may be obtained at their bottom, or of the land-area which may be reclaimed from their bed, or of the improvement of climate by the diminution of moisture, or of the obtaining of a level for the draining of adjacent meadows and marshy grounds, which cannot otherwise be accomplished. Land-locked morasses, water-retaining hollows, low and flooded flanks of rivers, great sea-board alluvial levels lying slightly above or even below the elevation of spring-tide altitude, and such seasonal or periodical lakes as the Irish call turloughs, are, in all instances, both fit and necessary subjects of surface-draining. Spots and places which become wet or flooded by accumulation of rain-water, stagnating on an impervious subsoil, and surrounded by higher ground without any gap or outlet for water, require to be drained either by forming a surface canal, or by perforating the impervious subsoil and letting the water downward into a porous substratum. But in order to afford a distinct view of the kinds of land which require either surface-draining, strata-draining, subsoil-draining, or combinations of these classes of draining—and particularly of the arable lands which may be improved in value by some of the nicer methods of subsoil-draining—we shall give some account of the general distemperature of soils, the causes of wetness, and the nature and origin of springs.

By the soil we understand that stratum which, forming the upper covering of the land, affords support and nourishment to the various vegetables, and is stirred and exposed to the sun and air by the operations of agriculture. The thickness of this stratum, or depth of the soil, is very various; but in general it either already does, or by proper management may be made to, extend to the depth of nine inches. Soils vary greatly in quality, and are seldom composed of any single substance: but with respect to drainage, they may be all arranged into two classes,—viz., the impervious, commonly called heavy or strong,—and the porous, termed light or weak soils. Of the former kind are clay, or the substances combined with it, as clayey loams. Clayey gravels, &c., black peat earth also, before cultivation, is of this kind. Of the latter are sandy, gravelly, or other light loams, peat earth before cultivation, stone brash lands, &c.

The subsoil is the stratum which lies immediately beneath the former, and may be supposed to extend from nine inches, or the distance to which the operations of agriculture extend, to about 2½ feet, or the depth to which the greater number of subsoil-drains are sunk, when intended to be covered by a stratum of earth, and passed over with the plough. The limits of this, however, like the former, are very variable; since, in many cases, uniformity of structure prevails to a great depth, while in others the soil lies immediately over rock, and may be said to possess no subsoil at all. The influence of the weather, the agency of manures, and the residence of the various plants and animals that inhabit the soil, are confined to the upper stratum. The subsoil therefore chiefly demands attention, by its effects in regulating the supply of moisture. If excessively porous and dry, the soil above it is liable to be parched, and becomes unfit for the existence of plants. If porous and wet, the health of the plants above it is injured, or they give place to the ranker aquatics. If the subsoil be impervious, similar consequences take place, according to the weather; but if the subsoil be open to a sufficient depth, the water which filtrates through the soil, or which rises from the bottom, will be there carried off without injury to vegetation; while, on the other hand, a reservoir of moisture will be within reach of the roots, in the event of long-continued droughts acting upon a light soil, and depriving the vegetables of their usual supply. When there is land which nature has not already provided with this necessary stratum, it is the business of man to supply it. The substrata must be opened or closed as the case requires, until the water remain at a due distance from the vegetable mould. The distance depends on the quality of the subsoil and bottom; for loams will hold the water much higher than the sand, and that again higher than gravel, owing to the greater capillary attraction of the smaller pores. The supply which is furnished or abstracted by the bottom, depends partly on its position, and partly on the specific composition of the strata.

The bottom or base of land is under the subsoil, comprehending everything below the common operations of culture and drainage. It is the seat of springs, formed by waters derived from higher grounds; and of swallows, which absorb or convey them off to lower. These have, in many cases, an important effect on the superincumbent soil, and their drainage is frequently necessary for improving the land; but it requires a particular mode of management, which shall be described under a succeeding head. Like the soil and subsoil, we may also class the various kinds of bottom into the porous and impervious; this being the most important distinction in the eye of the drainer. But it may not be improper to be somewhat more particular in distinguishing the more remarkable varieties of the strata of the earth, which will give us a better idea of the qualities of the various soils and subsoils, it being from the decomposition of the former that these last are formed.

The crystallized mountain rocks, such as granite, &c., seldom occur in situations fit for the labours of the agriculturist; it may be only observed, that having no fissures, they are impervious to water. They decompose into a sharp sand, which is one of the readiest conductors of water we have; and when covered by a clayey or loamy soil, and well drained, form valuable lands, producing great crops of potatoes and barley. The chief granitic soils are in Cornwall, part of Leicester and Cumberland, in England; in Galloway, Aberdeen, Ross, and much of the Highlands of Scotland; in Donegal, Galway, Wicklow, and Down, in Ireland. By far the greater part are moors covered by fibrous moss.

The various kinds of slate rock are composed chiefly of clay; and are therefore impermeable to water, except in their cracks and fissures, which, near the surface of the earth, are numerous. The strata or plates stand usually on edge, so that the water easily finds its way down into them, and, splitting the rock by its hydrostatic pressure, works by degrees the surface into a clayey loam. Under this the water sinks until directed to the surface by closer strata; and then forms springs, or watery land, according as it is in greater or less quantity. The ridges of the slate rocks running parallel for great distances, form narrow hollows, which are sometimes lakes, sometimes fibrous mosses, and can only be drained with effect by cross-cutting the strata. The ridges, on the other hand, are usually dry and fertile. This kind of rock occupies a great extent of these kingdoms, being found in Cornwall and Devon, most of Wales, Lancaster, Cumberland, and Westmoreland, most of the Highlands of Scotland, all the south and south-east of Ireland, and a band which runs from the shire of Berwick across the channel to the banks of the Shannon; also much of Derry and Donegal, and part of Mayo. There are, however, many varieties, the best and hardest slate being nearly impervious to water, and keeping the lands above them dry and sharp; while the softer, or shales, imbibe water in considerable quantity, and, parting with it slowly, keep the land above them constantly moist and cold.

The sandstone rocks of every kind are more or less porous, and transmit the water through their substance like a filter. They are found in great abundance in various parts of the kingdom. Often occupying the rising grounds, and usually of a reddish cast, the soil produced from them is dry, and, though meagre, not always unfertile. But the water passing through them frequently acquires a mineral impregnation from iron pyrites, which enables them to preserve vegetable matter from decay. From this cause we may account for the numerous bogs or mosses which disfigure the base and banks of the sandstone hills, where water is frequently oozing, and the bottoms of the deep sand districts, from which it has not a ready passage. The most effectual cure for it is draining, to remove the cause, and calcareous earth, to free the water of its antiseptic property, by neutralizing the contained acids.

The calcareous rocks are very various in texture. Soft and granulous kinds occur in the chalk formations of the south and east of England. The oolite of Bath, the Coteswold, &c., is of a porous and absorbent nature, and imbibes the rain into its substance as fast as it falls. The water descends, as in a filter, still more readily than in sandstone rocks, until it come to an impervious stratum, by which it is conducted into the sea, or thrown out on the surface in the form of springs. The chalk is only found to the eastward of a line from Dorchester to Sunderland. The harder kinds of chalk and limestone, though closer in their texture in the individual specimen, are usually, in the great scale, divided by numerous chasms and fissures, some of them opening into enormous caverns, of which those in Derby, and in many parts of Ireland, are very striking instances. This kind of rock, where uncovered by other soil, is consequently as free a conductor of water as we know; even large subterraneous rivers sometimes pass through it. The most striking example in these kingdoms is perhaps that of Lough Mask, in the west of Ireland, where the waters of a bason, of 250 square miles, pass for two miles under ground into Lough Corrib. Many such basons are alternately dry land and fresh-water lake, according as the supply is less or greater than can be conveyed through the syphon, which forms their outlet. The Cirknitz sea in Austria is of this kind. Such lakes are named Turloughs, *i. e.* Landlakes, in Ireland, and are very common in Connaught. There Turlough-More, near Galway, covers an extent during winter of several thousand acres.—Another sort of limestone is the magnesian, or water lime, occurring at shallow depths, and bedded in clay. It is particularly remarkable for making lime, which will set and harden under water; so that when applied to land, it has just the opposite effect of common lime, as far as drainage is concerned, binding and consolidating the soil, instead of opening it. —The limestone strata occupy a great extent of these kingdoms, particularly in England and Ireland. One great field runs from Berwick to Lancashire and Derbyshire. The chalk also occupies most of the south and east of England; and, in Ireland, the greater part of Leinster and Connaught is a limestone country. There are also many smaller tracts. There is but little limestone in the north of Scotland, though it abounds in the middle or lowland tracts, forming usually the bason of the coal strata; as is likewise the case along the Severn. The magnesian lime begins at Sunderland, running southwards through the middle of England, and turning off towards the Bristol Channel.

The coal strata are very various. The coal itself is porous. The clunch shale or till is impervious, being chiefly clay, and well-adapted to cure the defects of the deep sandy soils. The coal sandstones are usually somewhat argillaceous, and consequently not unfertile. The greatest tracts of coal country are from Bristol to Morpeth in England; on the Forth and Clyde in Scotland; and in Leitrim and Kilkenny in Ireland.

The greenstone, and green conglomerate or porphyritic rocks, produce, by their decomposition, soils exceedingly fertile. The finer paste becomes a loam; the larger pebbles form an open substratum; the rock itself is generally close and retentive, though capable of imbibing a considerable portion into its substance. Basalt, though an argillaceous rock, imbibes water into its substance and parts with it slowly. It decomposes chiefly into an ochery earth, which is loose and porous on the hills, but in the deep bottoms forms a strong loam upon clay. The counties of Antrim and Londonderry in Ireland, and the Ochil and Campsie hills, and some of the western isles in Scotland, are the chief basaltic countries. The castle-rock of Edinburgh, and neighbouring hills may be also noticed, as examples of greenstone. The basalt hills are noted for abounding in springs, which descend through their upright fissures, and are thrown out by the clay at their bottom.

Of the alluvial strata, clay is an important member, and forms the chief material by which other strata are rendered impervious to water. When exposed, however, to continual drought, it shrinks, and cracks sometimes to great depths, thereby admitting water afterwards to penetrate it with comparative ease. Clay, therefore, is of itself not so thoroughly impervious as when duly mixed with sand, gravel, or loam, which prevent it from shrinking to so great an extent. Gravel of every description, from its open nature, is the most effectual of all conductors of water, at least when free from the admixture of earthy matter; for in this state it seems to aid the retentive nature of the loam, a mixture of it being frequently preferred for puddling hydraulic works. Where an open gravel is covered with strata of clay or earth, it is one of the most common causes of springs and watery land, the cure of which shall be treated of hereafter. Sand being formed of smaller particles than gravel, differs from it only by the slowness with which the water passes through, and the greater height to which the capillary attraction makes it rise. In other respects, its properties are similar to those of the sandstone rocks already described. Loam varies according to the substances with which it is combined; but in general it may be considered as retentive of moisture, at least after it is once thoroughly saturated and puddled, to use the technical phrase of drainers.

Moss-peat or bog is of two kinds. The flow moss or red bog of Ireland is a fibrous mass, composed of undecayed vegetables of the moss kind; it retains water like a sponge, by capillary attraction, and after drainage shrinks and compresses considerably. The other kind is that called black bog, in which the vegetable fibre of the mosses has undergone a certain degree of decomposition. This substance, though light, is totally impervious to water, and is frequently used in hydraulic operations for puddling, where good loamy earth or the like is not to be had. But after peat-moss has been broken up and pulverized by cultivation, it permits the water freely to percolate, insomuch that the upper parts of the ridges, especially when they are much raised, are apt to have the crops fail on them during the slight droughts of summer. Dried peats are quite impervious to water.

Springs are formed, or have their origin in the different strata of the earth, by the rain-water which falls upon it and sinks into those which are of a porous nature, and descends until it meets with a bed of clay, close gravel, or impervious rock; upon this it either passes along down the declivity of the bed, soaking through the porous matter which lies over it, or it collects, as in a reservoir, until it is emitted at some part of the surface of the ground, forming all the different phenomena of springs, &c., which are so often met with. Hence we see, that in countries of deep sand or gravel without beds of clay to force the water to the surface, abundant springs are not to be met with; and again the deep clay countries are equally destitute of spring water until we descend through the clay into a bed of sand or other open stratum, the only situation in which the water can flow in abundance, and in which it is only made to pass horizontally by a bed of clay or other impervious matter opposing its further progress downwards. If this bed or floor of clay, instead of coming to the surface, should have its lower edge terminating in the sea, a deep lake, or the bank of a river, the water which has descended into it will find its way into these natural receptacles, without ever making its appearance on the surface of the land; and there can be very little doubt but that much of the water which falls on the dry land escapes in this way without being perceived. But if, from the unevenness of the surface of the land, and the abruptness of the strata, the lower edge of the impervious bed should anywhere reach the surface, as is frequently the case on the sides of hills, in deep dingles, &c., the water, which was collected in the porous strata above, will there make its escape, and as a considerable time must be required for its passage through the obstructed interior channels, the intervals of drought will not always be sufficient to admit of the whole being delivered before a new supply comes again from above. In this manner a frequent or even continual oozing of water may be formed; and if it be not confined to a narrow channel, but allowed to spread over the grounds below, plots of watery land will be formed, and in time covered with aquatic vegetables, which, by their decay are converted into peat or bog.

Several obvious and very important inferences suggest themselves from these views of soils, substrata, and springs. One is that lands ought not to be indiscriminately drained. We have seen on one farm of very heterogeneous surface, a single or uniform system of subsoil-draining practised upon spouty, spongy, and hollow-lying morass, upon varieties of loamy soil incumbent principally on stiff impermeable till, and upon thick and homogeneous deposits of silicious sand, which lay upon an inclined plane, and were known to have a depth of at least about 12 or 16 feet. Such monstrous practice provokes the pity or derision of scientific agriculturists, occasions wasteful expenditure and bitter disappointment to its perpetrator, and is powerfully fitted to bring all draining into disrepute among the large class of farmers who labour more on imitation than on principle.—Another inference is, that, while surface-draining is sufficient for many hollow places, and strata-draining is sufficient for many springy or spouty grounds, some variety of subsoil-draining is requisite for all arable lands which have either clay soils or retentive subsoils, and certain combinations of two methods of draining—of the surface and the subsoil methods, or of the strata and the subsoil methods—are needed by some peculiar kinds and positions of absorbent lands.—Two other inferences are, that soil and substrata of thirsty sand or gravel require to be treated on the very reverse principle to that of draining, and that clay lands, in the exact proportion of their clayeyness, are those which require the utmost powers of draining; and these two inferences, particularly the latter, demand somewhat extended notice.

Open soils, whether sandy or gravelly, occur chiefly in extensive flats either along the sides of estuaries or upon plains near the sea and very slightly above its level. Where the materials of these soils, though sufficiently open to prevent any surcharge of water, have yet such a due proportion of tenacious matter as to preserve the water from passing too rapidly away from the roots of the vegetables, the land is of a highly valuable kind. If this be not the case, and the soil be so open as to permit the water to flow quickly away through the porous substrata, the land is in a great measure useless. A few plants are, however, fitted to this kind of soil; and by encouraging their growth and decay, there will at length be formed from their exuviæ a vegetable soil, which will in a great measure cure the defects of the original, and approximate it to a soil of deep loam upon a subsoil of gravel or sand. In this way the Scots pine has been often employed for the reclaiming of a deep and churlish sand. The *Psamma arenaria* or *Ammophilla arundinacea*, a bent grass, is also cultivated on sands; and besides retaining them from being transported by the winds, forms by degrees a soil over them fit for other plants. One obvious corrective for deep porous soils, is powerful and constant irrigation, which, independent of the supply of moisture thereby afforded to the vegetable, will also by degrees operate a change on the soil itself; for the finer particles of mould brought by the water, will enter a little way into the substrata, and fill up their pores, as happens with a common filtering stone.—Where light soils are in constant aration, the plough works a certain proportion of the mould into the subsoil immediately under the part which is constantly stirred, and thus a thin water-tight partition is formed between the soil and the subsoil, by which the manure and moisture are prevented from sinking too rapidly. The Norfolk "pan" is a stratum or partition of this kind, and is without doubt the chief cause of the fertility of the light sandy lands of that country. It has most probably been formed, partly by the application of marl and clay, and partly by the continued friction of the plough, regulated by a wheel, so as at all times to run precisely at the same depth, which may act in the same way as the polisher on the granulous surface of sandstone or marble. It is well known, that whenever the "pan" happens to be broken by the plough or otherwise, the soil is materially injured for a length of years.—To deepen the soil by laying it up in drills, and to compress the surface by the roller, are also at times advisable, and are well known in the Norfolk turnip husbandry, though frequently blindly copied upon soils which have no need of such an operation.—The consideration of this case will illustrate the propriety of the old adage,

He that marls sand,
Will buy land.

Peat earth, after cultivation, comes also under this case; the soil being so loose and open, that water escapes more rapidly than from any other soil. Hence, again,

He that marls moss,
Will make no loss.

But in the cultivation of mosses, the flatness of the land, and retentiveness of the bottom soil, always afford an easy remedy against drought, unless we deprive ourselves of it by mismanagement.

Clay lands are very various in both chemical and mechanical character,—some having a homogeneous soil and subsoil, and others a soil very different from the subsoil,—and some being purely and finely argillaceous, others arenaceous or loamy, and others calcareous or of the nature of till; yet all, as well as the raw and pasty kinds of uncultivated peat bog, possess the property of strongly resisting the permeation of water, and, in consequence, are pre-eminently needful of the operations of thorough-draining. The discomforts, difficulties, distemperatures, and losses of an undrained clay farm are great, constant, and almost numberless. The farmer does not know when he may be able to plough or to sow; he frequently cannot allow his teams to go on the land, and is compelled to keep them idle; he often stands gazing and appalled at a great and growing accumulation of the labours of tillage; and, when a favourable time for action arrives, he has far fewer facilities, and requires a much greater amount of horse-power, than a light-land farmer, for performing the several departments of field-work. In a wet autumn, he must either sow his wheat too late, or not sow it at all; in a wet winter, he is unable to forward the work of tillage, and may suffer the mortification of seeing his wheat seed-corn rotting in the ground; in a wet winter and spring, he may have his furrows so drowned, that all the wheat-plants near the hollows may perish: and in a wet spring and summer, he may be grievously embarrassed, and all but utterly baffled, in his efforts to sow his spring-corns, to elaborate his turnip grounds, and to conduct the operations of summer-fallowing. His ploughmen and his horses, on the one hand, expend their strength in exertions to reduce the stubborn clay to mould; and the weather, on the other hand, works quite as mightily to reduce the newly-formed mould into persistent and impenetrable clay. Some clay farms are so hard and metal-like in droughts, so tough in their best state of moderate moisture, so deep, pasty, and impassable in wet winters, and so cold and backward in even averagely genial springs, that farmers who are accustomed to warm, sound, practicable, grateful land, say they would not accept the tenancy of them even free from all rent. When the occupiers of such farms are good farmers they lose one-half of their exertions, and are dismally ill-compensated for the other half; and when the occupiers are bad farmers, they speedily sink into circumstances as poor, refractory, and woe-begone as those of their miserable fields. Yet clay farms make more ample, ready, and prolonged returns for capital expended on them, in draining and in subsequent manuring, than any other class of lands. Clay-farms, once properly drained, need little other management than is comprised in the two simple arts of common ploughing and of making farm-yard manure. Though clays might advantageously make over to gravelly or sandy soils their own excess of moisture; yet, on the other hand, they do not exsiccate and become parched like these under the play of summer sunshine, and they carefully treasure up within their recesses, and prevent from being wastefully drawn off in gases, whatever manure is expended on them till it be required for the feeding of the crop. Top-dressing and ploughing in with silicious sand, liberal dosing with lime or other calcareous manure, a judicious degree and infrequent repetition of paring and burning, and the free intermixture of any gritty and non-absorbent substance which may effect porosities and other openings among the clay,—these and some other georgic operations directly tend to improve almost any kind of clay lands, and may, in not a few instances, be both facilely and profitably performed; but deep underground draining is the grand resource; this, in fact, is the cure, while the others, inclusive of trenching and of mere subsoil-ploughing, are nothing more than palliatives. Deep hollow draining, whether by pipes, little aqueducts, or any kind of permanent conduits, perpetuates the perpendicular fissures which are made by drought, —multiplies and ramifies these fissures into numerous and intricate cracks and breaks, occasions all the earthy mass above it, and especially the portions of the mass near the surface to be permanently dissevered into fragments by a kind of cubical net-work of cracks,—and imparts power to the roots of plants and to the organic matter of vegetable manures, to the depth of eight or nine inches from the surface, to intermix with these fragments, and speedily to form in combination with them as kindly and pulverulent an arable material as the best natural turnip ground in the world. The grand action of drains is to perpetuate and multiply perpendicular fissures, so as to render clay as permeable through these fissures as sandy lands are through their pores; this action, within certain limits, is powerful and ramifying in proportion to the height of range throughout which it acts,—or what amounts to the same thing, in proportion to the depth at which the pipes, aqueducts, or conduits are situated; and as percolating or descending water will not begin to flow horizontally till it ceases to have free passage perpendicularly, deeply situated drains astonish the vulgar—aye, and some others besides the vulgar—with the phenomenon of drawing off surface water more rapidly than shallowly situated drains. But a full view of this subject will come out in connexion with our statement of the various methods of subsoil-draining; and as clay-lands, even in their relations to draining-operations, are of various character, we shall take a further though brief notice of them under the three divisions of clay or stiff loam upon impervious substrata,—clay or stiff loam upon pervious substrata,—and sand, gravel, or light loam upon clayey substrata.

Clay or stiff loam upon impervious substrata, or a retentive clay so deep as to constitute at once soil, subsoil, and basis, is by far the worst class of argillaceous land, and of course the most needful of draining. In its uncultivated state, it is either nearly barren of useful herbage, or a mere bed of mosses and bogs; and in its cultivated state, it exhibits, in an exaggerated form, all the evils which we have mentioned as incident to the whole family of clay lands. In this case, the rain water, after saturating the surface, being precluded from penetrating farther, can only get away by the slow process of evaporation. The soil is therefore continually moist and drenched during winter. Cattle passing over it poach the surface, and fill it with numerous cups or holes, from which the water cannot escape even though the surface have a considerable fall. The spring shoot of grass is late; the produce in wet summers is rank and coarse. On the other hand, in dry summers, the moisture is rapidly diminished; and as no supply can arise from the subsoil or bottom, the surface dries and hardens, cracking into gaps, which allow free admission to the sun and air, so as to scorch up almost every plant that is sowed upon it.—In tillage, it is heavy and difficult to work, and is cropped with uncertainty; and the semifluid clay, while the crop is young, is liable to close upon the roots of the plants, and suffocate them by cutting off the supply of air. "The wetness of this kind of land," remarks Dr. Anderson, "is not occasioned by springs, but originates entirely in the proper waters of the site, or what immediately falls upon it from the clouds. In copious rains, a part of the water finds its way along the surface into the furrows, if such have been made, and by which it will be carried off the field; but a considerable portion also sinks down into the porous soil on the top, until it reach the solid bed of clay below, which never having been stirred or opened effectually, resists the passage of the water, so that it can penetrate downwards no farther. In consequence of this, it must force its way laterally towards the furrows through the upper mould; or if no furrows are provided to carry it off, it must gorge up the soil, and remain as in a bason, in which the superficial soil is mixed with the water in a thin paste, which remains of a soft consistency during wet weather, and in that state must be extremely injurious to the vegetation of plants.—When the dry weather returns, the sun and air will evaporate it, when the soaked paste, now deprived of its moisture, assumes a hard irony consistence, equally unfit for the sustenance of plants as in its moistened state."

In many parts of Great Britain and Ireland occur vast tracts of poor, hungry, clayey soils, that are all reducible to the class of which we now treat. They have been denominated "hungry," from the sudden disappearance of the effects of manures that have been laid upon them: they are also called "hide-bound," because of the hard stiffness, and miserable appearance of the surface. Few soils are in their present state more unproductive than these. Yet there are none, perhaps, which, under a judicious management, could be rendered more productive than many of them. It often happens that, over the whole surface of such soils, a thin crop of weakly rushes is produced while it is allowed to remain in grass; and a growth of hypnums and sphagnums, establishes itself there during the winter months, and is almost the only vegetable production, and gives a sickly verdure to the surface. Upon examination, it will be found that, in all cases of this sort, the unloosened clay rises very near the surface; in consequence of which, the superficial mould which has been stirred by the plough, to a small depth only, being thinly spread over it, is subject to be drenched through its whole depth by every violent rain, the manures completely washed out, and the whole reduced to a pappy paste, that becomes hard like iron when the summer heat dissipates the moisture. Under these circumstances, whatever manures or cultivation are bestowed on it, are in a great measure thrown away, as they are seen to produce but very little effect, and these soils are therefore in a great measure abandoned as hopeless.—Many soils of this description, however, if opened to a greater depth, may be gradually brought into a state of greater productiveness. Indeed many of the most productive districts in this kingdom consist precisely of soils that were originally of this kind.

Clay or stiff clay loam upon pervious substrata, whether these be sand, gravel, or a mixed deposit, is, in most instances, a soil of much intrinsic value, and not difficult of thorough subsoil-draining. When the ground lies upon an apparent level or a very slight descent, and when the soil has, by long working, acquired a large intermixture of humus and salts from the roots of plants and from manuring, it may probably be quite dry enough in droughty seasons, and may require draining only as a provision against the effects of wet winters, of rainy summers, and of occasional extraordinary falls of moisture. When the ground lies with a long descent, the water may possibly stagnate throughout the subsoil in the lower part of the descent, and may constantly press up against the soil and as thoroughly saturate and damage it as if both soil and subsoil wholly consisted of absorbent clay; and, in this case, the necessity for draining is of the utmost urgency. When, in flat districts of clay or stiff loam upon pervious substrata, ditches or main drains are not formed with a sufficient descent for free and rapid disgorgement, and especially when they are so level or ill-kept as to stand full of water, they may gorge all the subsoil, and occasion the same saturation and mischief to the land as if both soil and subsoil were absorbent and retentive. At no point ought water to be allowed to stand in a ditch, or pond, or main drain, upon this kind of land at such a height beneath the lowest part of the adjacent surface as to prevent the subsoil from running thoroughly dry to the depth of at least 16 inches below the basis of the soil; and if a sufficient fall for freely carrying off all substratal water do not naturally exist, one or more must be obtained by artificial means. One good appliance in some bad cases of this description is to form, through the subsoil, along the bounds, a wall of clay, to serve as an underground embankment and keep off the influx of waters from the exterior; yet this, of course, is altogether a one-sided advantage, and is fitted to induce upon the land without a greater amount of injury than it averts from the land within. When a deep, strong soil of calcareous clay, such as prime and very fertile limestone land, rests upon gravel, sand, or stratified rock, it may, without any draining whatever, be in the best condition for retaining and enjoying the normal proportion of moisture; and when soil of this nature is thin, and lies upon thoroughly porous subsoil, it is, in many instances, even in spite of possessing much tenacity, so liable to be parched and scorched in droughts, that underground draining would damage it, and a small degree of similar treatment to what is proper for thirsty arenaceous soils is required. In some cases of this latter kind, advice has been given to form an artificial adherent bottom similar to the Norfolk "pan," and to construct puddle walls at dead levels and in such a manner across the slope, that they may retard the descent of the substratal waters.

Sand, gravel, or light loam upon clayey substrata, is, in multitudes of cases, scarcely a degree better than a thick and deep surface-stratum of homogeneous clayey matter, and usually requires a similar system of deep and operose subsoil-draining. In wet seasons, the crop upon it is liable to be chilled and rotted, by the water stagnating throughout the soil and around the roots till slowly carried off by evaporation: and in dry seasons, they are just as liable to be dwarfed and blighted by the scorchedness of the soil, and by the impossibility of drawing up moisture from below. In all ordinary conditions, aquatic weeds grow and accumulate with most mischievous rapidity; and throughout a large portion of the year, but especially throughout winter and spring, the soil becomes fearfully poached by the tread of cattle, or rather is totally unfit to let cattle touch it.—A peculiar variety of clayey subsoil is known in some parts of Ireland, particularly in the county of Sligo, under the name of lack-lea, and consists of a hard clayey stratum interposed between a light or loamy soil and an open gravel bottom. This case seems to admit of easy cure; yet is very liable to be grossly mismanaged. The mere piercing of the clayey stratum allows all surplus water to pass readily through to the gravel bottom, but deprives the soil of all the advantages of an upward circulation during a hot and arid condition of the soil, and may in consequence occasion parchedness and ruinous injury during droughts. An obvious though slovenly, wasteful, and uncertain management is to lay up the soil in beds with intervening alleys, to pierce the clayey stratum with holes along the alleys during the prevalence of excessive wet, and to stop up the holes at periods of transition from wetness to seeming drought. The effectual treatment, and eventually the cheapest, is to work the clayey stratum and a portion of the underlying gravel, by means of trenching or of subsoil-ploughing, into a homogeneous subsoil; and then the land will possess the same advantages of draining, and the same high powers of fertility, as if it naturally consisted of a finely porous soil immediately incumbent on a normally porous subsoil.

Surface-Draining.—The mere surface-draining of wet arable loams and ordinary clays is always an inefficient and uneconomical operation,—failing in a great degree to effect requisite dryness of soil and occasioning a wasteful expenditure of at once labour, land-area, manure, and the richest portions of the soil; yet it is much preferable to a total want of draining, and may be regarded as indispensable to cultivation on all farms which are prevented by minute subdivision, by poverty, or by prejudice, from receiving the advantages of proper underground draining. The performance of it is very simple and very easy; and yet on multitudes of the small farms of Ireland, where it is peculiarly and eminently needed, it is miserably neglected. The ridge and furrow system is, of course, indispensable to it; and care should be used to have the ridges raised to such a slope as will occasion the free riddance of heavy rains, and to have the furrows so regular and open as to offer neither hollow nor obstruction for the partial stoppage of the descending water. In fields or farms, which have considerable declivity of surface, the furrows, and of course the ridges, should be formed —not directly down the declivity, else they will carry off large portions of the most fertile ingredients of the soil, to be deposited in the ditches and swept away toward the sea—but obliquely across the declivity at such an angle or with such a slope as merely to afford a free descent for water, but without permitting it to acquire any considerable velocity in the escape. An old practice of the farmers of clay districts in England—a practice which all the enlightenment and mighty agricultural progress of the nineteenth century, have not altogether extinguished,—was to dispose the ridge and furrow upon a slope in a gently winding manner, so as to prevent descending water from having a rapid flow, or from acquiring excessive power of washing away soil and manure. An important rule on all ridge and furrow fields, especially when no underground drainage exists, is to maintain the furrows at a proper and regular depth, and perfectly free from all obstructions. "I have often," says Mr. George Stephens, "seen large tracts of clayey land intermixed with whitish stones, lying in subsoils, perfectly impervious, effectually drained by means of trench-ploughing, and keeping the furrows regularly deep from one end of the ridge to the other. If farmers occupying clayey soils would pay more attention to the formation of the ridges and furrows, and keeping the open ditches and cross-furrows sufficiently deep to clear the surface of all the stagnant water in the hollow parts of the fields, there would be much less necessity for making drains for removing surface-water."

A somewhat peculiar method of surface-draining, consisting of open ditches, gaw-cuts, or cross-furrows, and pows, large main drains, or receiving canals, has long been practised in the Carse of Gowrie, and is still regarded, by the less enterprising class of agriculturists, as quite sufficient for the purposes of that rich wheat-bearing district of unctuous clay. Yet it occasions a considerable annual expenditure of labour; it obviously wears and wastes some of the very best portions of the soil; and it offers not even the pretence of a substitute for any one of the advantages which result from deep subsoil-draining. "This mode of draining," says Mr. Henry Stephens, in his 'Book of the Farm,' "does not profess to interfere with any water that exists under the surface of the ground, farther than what percolates through the ploughed furrow-slices, and makes its way into the open furrows of the ridges. For the purpose of facilitating the descent of water into the open furrows, the ridges are kept in a bold rounded form; and that the open furrows may be suitable channels for water, they are carefully water-furrowed, that is, cleared out with the plough after the land has been otherwise finished off with a crop. The gaw-cuts, small channels cut with the spade, are carefully made through every natural hollow of the ground, however slight each one may be, and the water-furrows cleared into them at the points of intersection. The gaw-cuts are continued along the lowest head-ridge furrow, and cut across the hollowest parts of the head-ridge into the adjacent open ditch. The recipient ditch forms an important component part of this system of draining, by conveying away the collected waters of the field of which it forms the boundary, and for that purpose is made as much as 4 or 5 feet in depth, with a proportional width. It is immediately connected with a larger open ditch, which discharges the accumulated waters from a number of recipient ditches into the river or lake or other receptacle which is taken advantage of for the purpose. The large ditch is from 6 to 10 feet in depth, with a proportional width, and, when conveying a full body of water in winter, appears like a small canal." This system obviously does nothing more than draw off excess of surface water,—drawing off, at the same time, saline matter, liquefied manure, and thoroughly comminuted soil; and it makes no provision whatever for the pulverulence of the land, for its aeration, for the elevation of its temperature, for the increase of chemical action upon its materials, and for the free circulation of moisture and atmospheric gases throughout its interior. The farm-labourers of the carse, too, expend upon this system an enormous amount of spade-work, in originally making the gaw-cuts, in both clearing these cuts and otherwise directing the rills of accumulating water after every heavy fall of rain, in annually scouring out all the smaller ditches, and in periodically scouring the larger ditches and revising the whole ramification of the drains.

The peculiar water-furrowing of the Carse of Gowrie, however, commended itself to the approbation of Sir John Sinclair, and is recommended by him as applicable "to all tracts of clay similarly circumstanced;" and a general water-furrowing of all strong land is strenuously inculcated by him, by Arthur Young, and by almost all other eminent agriculturists preceding the recent epoch of deep and thoroughly effective subsoil-draining. "The necessity of making these water-cuts or furrows in wet fields, as soon as the plough leaves them," says Sir John Sinclair, "is strongly inculcated as essential for the future dryness and fertility of the land. The cuts ought to be frequently examined, more especially after the melting of snow, to see that no impediment prevents the free passage of the water. The cutting of water-furrows ought likewise to be carefully attended to after spring-ploughing, to prevent water from lodging in any part of the field, however wet the weather, and for that purpose, the headlands should be cut through, where necessary, that water arising from any sudden flood may have a free passage. The spit of earth dug out of the water-furrows should be laid on one side, opposite to the rise of the land, to prevent overflowing, and all the loose mould carefully shovelled out. This simple operation of water-furrowing is attended with such beneficial consequences, that wetness may often be removed by such means alone, without the aid of additional drains; while the omission of it, may not only lessen the crop, but injure the soil for some time afterwards." On all retentive lands which have not been dried by subsoil-draining, this system of water-furrowing continues, of course, as important as ever, yet is a mere appendage of the general system of surface furrow-draining.

A cheap and facile system of surface-draining has been somewhat extensively practised on sheep-walks or hilly pastures, by means of what are called sheep drains; and when this system is restricted to grassy hills with an immediate subsoil of impervious clayey matter, without any such outburst of springs or spoutiness as to demand the operation of strata-draining, it is both appropriate and efficient. When the sward is fine and smooth, the drains, or at least all except the principal ones, may be formed with the plough, and finished with the spade; but when the sward is course, or the surface is intersected and dappled with little swamps, they must be both formed and finished with the spade; and in either case, they consist of a few main drains and a considerable number of feeders, both cut at such an angle or upon such a diagonal across the slope as best to promote the joint drawing and flowing of water,—the main drains so disposed as to effect the chief part of the perpendicular descent, and the feeders coming into these in nearly rectangular directions. Yet simple though this method be, and not a little effective in improving at once the climate, the herbage, and the health of stock in clayey pastoral districts, it has been thought by some careless and partial observers to have a tendency to diminish the growth of the grasses, and correspondingly decrease the value of the pastures. But an argument in Mr. Arkell's Prize Essay, though addressed to the far higher question of subsoil-draining the wet grass lands of arable farms, ought to annihilate every doubt. "Strong land that is wet in the winter, becomes dry in the summer, cracks, and requires more rain to make the grass grow than land of the same nature that is drier; but after strong land has been drained a few years, it becomes milder, never getting so hard in summer, nor so wet and soft in winter. I should say that, when water stands on the surface, and is left to evaporate by the heat, then there is an excess of moisture. On wet sour-feeding middling grass land, I think there is no doubt that draining would be beneficial; but it would be more likely to lessen the quantity of grass on this description of soil, which generally grows a coarse, sour sort of herbage; still the quality will be improved and the old saying will apply here, 'A lark is worth a kite.' Some, perhaps will argue differently, saying that the wettest part is at present the best, viz., the furrows: so they are, if they are not trenched out, because the water running off the ridges by the furrows causes a natural water-meadow just down the furrow; but it is easy to see which is predominant, the injury to the ridge, or the benefit to the furrow. You cannot indeed expect by draining middling or bad grass land to make it good directly, but the land will improve afterwards: the manure, whether carted on, or produced by feeding off the grass, will be more beneficial by being all washed into, not off the land, as is now the case."

The draining of ponds, lakes, and land-locked morasses sometimes affects a comparatively small extent of area, and is then so simple and obvious an operation as not to require any description. But the draining of these on a large scale, the making of tunnels or deep cuts through hills for the withdrawal of the enclosed and accumulated waters, the cutting down or deepening or altering the channel of a large stream so as to modify the levels of natural drainage throughout large portions of its basin, the protecting of great tracts of periodically flooded meadow or alluvial flats by means of embankments, canals, sluices, and hydraulic machines, and the reclaiming from the dominion of the tide expanses of salt marsh or great, low-lying flats of grassy fen, are operations which usually require the pecuniary resources of government or of associations, and the skill, experience, and prolonged superintendence of civil engineers. The Bedford Level, the drainage of the fens of the south-west of England, and the protection from the sea of the vast reclaimed low plains of Holland, are works far beyond the means of all single farmers and even of almost all single proprietors. Yet a knowledge of the best methods of draining fens and other low-lying flats is often of great consequence to farmers; and the principles of them are few and simple, and may be readily comprehended by attending to the natural drainage of the district, in the ramifications of its streams.

The lowest attainable outfall must first be discovered, and, if otherwise obstructed, a main drain led up from it into the space to be unwatered. From this, there should be branches drawn into those which are not commanded by the main drain alone. The junctions with the main drain should be oblique, and pointing down the stream, that the influx of side waters may not tend to dam up those of the main. Into these branches, the fence drains of the fields are conducted in enclosed grounds, and the land is laid up in ridges and furrows, terminating in the boundary fence drain. Where the furrows are so situated as to run across a hollow, the waters of which they are not deep enough to discharge, the water furrow becomes necessary, and is drawn across them in the hollow ground, so that a general ventage may be given to every part of the surface by an unobstructed fall, which is greatest at first, but may be gradually diminished, as the quantities of water increase, by uniting until the whole is discharged into the sea. In searching for the lowest outfall, the spirit level must often be resorted to. There are, however, natural marks, by which the fall of the ground, and consequent direction of the flood waters, may be discovered in the flat countries. On examining the ditches, which become nearly dry in summer, it will be found that the leaves of the various aquatics, as the sisymbrium, the water cress, the brook lime, &c., invariably point down the fall, or in the direction to which the water passes. This observation is well known to practical drainers. It should always be kept in view, as the situation and direction of these plants will afford, in many cases, a more ready means of discovering the direction of the natural hollows than any other. During flood also, it is of consequence to mark the progress of the waters in their increase and diminution; and it is often advisable while they are stationary on the flats, to sound them, by inserting many pegs in the ground, so as to have their tops level with the water, by which means the heights and hollows are at once perceived by the different lengths of the pegs. This method is particularly convenient in laying out fields for irrigation by flat flooding.

With respect to the inclination or slope of drains, there are certain limits which must not be exceeded; the slope must be such as will at least permit the water to be carried off with sufficient rapidity to keep its channel clear, but not so fast as to injure it by acting on the sides or bottom. Mathematically speaking, the water should pass away with any the smallest inclination of channel, and even gradually accelerate in velocity. But we know that in fact this tendency to accelerate is speedily destroyed by the friction and other obstructions in the channel, and these increase in proportion to the smallness of the quantity of water, so that great rivers are enabled to move with less declivity than is required for smaller streams. This has not been sufficiently attended to in the operations on the great English fens; for, instead of uniting the upper waters into one capacious river, they have been divided and led away to different outfalls, greatly to the injury of drainage. Large and deep rivers run sufficiently swift with a fall of about 1 foot per mile, or 1 in 5,000; smaller rivers and brooks, with a fall of 2 feet per mile, or 1 in 2,500; small brooks hardly keep an open course under 4 feet, or 1 in 1,200; ditches and covered drains require at least 8 feet per mile, or 1 in 600; furrows of ridges and filled drains require much more; the elevation of ridges measuring across, is, according to the soil, sometimes as high as 1 in 10. Where the ground is level, and there is not in the direction of the smaller drains a fall equal to the above, it may be given in the formation of the drain itself, by cutting it deep at the outfall, which is preferable to widening merely.

The limit to the increase of the fall depends on the cohesion of the stuff in which the drain is cut. Firm rocky bottoms may be supposed to bear water passing over them at any slope; but, independent of the old adage, that even the drop wears the stone, the gravel and boulders, which are likely to be brought down by swift running streams, are, by their battering and rubbing, equal to the destruction of the hardest rocks. In brooks and rivulets a fall of 1 in 10 over rock, or of 1 in 30 over large stones, or of 1 in 50 over smaller stones, or of 1 in 70 over ordinary pebbles, or of 1 in 100 over small pebbles, has the velocity of a torrent; a fall of 1 in 200 over very small pebbles, or of 1 in 400 over fine gravel, has the velocity of a rapid stream; a fall of 1 in 600 over coarse sand, or of 1 in 1,000 over common sand, or of 1 in 2,000 over muddy sand and clay, has the velocity of a gentle stream; and a fall of 1 in 4,000 over mud, soft clay, and some aquatic weeds, or of 1 in 6,000 over ooze and many aquatic weeds, has a dull and sluggish motion, the slowest which belongs to flowing water. But in rivers, these velocities, over their respective beds, are greater than in brooks and rivulets; and in rills and drains, they are less,—so that a declination of 1 in 4,000 over mud or soft clay in a small drain, or even sometimes in a large one, would practically be a dead level, and would cause perfect stagnation. Straight and even channels also permit the water to flow much swifter than where it has, with the same slope, to wind round the different sinuosities of the natural bed, to pass over shoals, or through narrows. It may be observed, that a bottom of fibrous bog will bear a greater velocity than any loose earth or gravel. The intermatting of the fibres prevents them from being torn away. Accordingly, bog drains stand well, even upon great slopes, if they are not cut to the under stratum; but where that is the case, as it is generally found to be gravelly or sandy clay, the bottom speedily gives way with the stream, and the drains choke, or blow up if they are hollow.

It appears, therefore, not only advisable, but even highly necessary, to draw in sloping ground the drains across the slope, so as to be nearly on a level, since a fall of 1 in 600, the greatest that is absolutely necessary, is not sensibly very different from the horizontal. This disposition of the drains at the same time enables them to catch and collect the water as it descends through the soil down the slope, and prevents the same water from successively moistening lower and lower pieces of ground. This principle, however, is by no means generally understood by common farmers, among whom, in many cases, the only idea seems to be to carry away the water as fast as they can; and this they attempt by perpendicular parallel drains running down the slope, or by many branches collecting rapidly into one main down the hollows. They do not observe, that, in these cases, the water which falls on the field, unless it happens just to fall over one of the drains, is not in the smallest degree assisted in its passage away; for it will most probably descend through the loose arable soil, until it comes to the firm bottom, and then, as it can have no tendency to proceed sidewise into any of the drains, it must continue to trickle down the slope until it arrive at the bottom, in which situation a drain, though it may perhaps afford it a more unobstructed passage, can give no more fall than originally existed on the surface of the field.

The dimensions of open drains will chiefly depend on the nature of the soil, and quantity of water to be conveyed by them. The best form for facilitating the passage of the water, is to make the slope on each side 16 inches of base to a foot of perpendicular height; the breadth at bottom may be two-thirds of the depth of water, unless particular circumstances make it desirable to widen the channel so as to lower the surface. As to water-way, we have usually found the channels of rivers and streams running about two feet per second to contain about a square foot area of section for each hundred acres of drainage; but this will vary according to soil and climate. The usual size of the smaller ditches running through farms are three or four feet top, one foot bottom, and about three feet deep; but it is difficult to preserve the sides so steep.

When the site is liable to be injured by foreign waters descending into it from the conterminous upper grounds, it is most advisable to cut them off at higher levels, before they descend into the flats, which, by this means, will have only their own waters to discharge. For that purpose, the catch-water drain must be resorted to, being drawn along the boundary of the upper grounds, so as to intercept the springs and streams flowing from them, until a convenient opportunity be found of discharging them into the receiving stream. It frequently happens that the water which is thus procured affords sufficient power to work hydraulic machinery, by which the neighbouring low lands may be freed from their proper waters, even when they have no natural outfall.

When the natural channel of the foreign waters lies through the site to be drained, as is the case with most rivers which overflow their low grounds, it is commonly necessary to confine them with embankments on either side, to prevent inundation in time of floods. The size and dimensions of the embankment must depend on the depth of water and reach of the waves to which it may be exposed. They must not only be high enough to keep out floods equal to the highest previously known, but also those which may occur after the space over which they used to spread has been diminished by the embankment. The floods of all rivers increase after embankment, since they are not only deprived thereby of a certain portion of channel, but also of those natural basons or reservoirs which used to receive the surplus waters of sudden swells, and of course regulate the supply to the lower reaches of the river. See the article EMBANKMENT.

The drainage of embanked land, whether that land be reclaimed from the freshet flooding of a river or the tidal flooding of the sea, is conducted on the principles already stated. When an outfall sufficiently low can be found, a back drain runs along the inside of the embankment, until a proper opportunity occur of discharging it. For that purpose it is sometimes necessary to convey the channel under the bed of the river itself, or some embanked branch of it, which is done by means of a pipe of stone or timber, called a fox, or culvert. Where the embankment is only against floods or the tide, an opening is made through the bank itself to shut with a valve or floodgate against the exterior high waters, and which being opened when they have subsided, permits the internal waters to escape.

In cases where this is not practicable, the waters must be lifted by artificial means over the bank.

Flood-gates are variously constructed: the simplest for our purpose is a valve or clapper, hanging by the top, and falling against the end of a pipe, or against a sluice frame; at other times sluices or paddles are made to slide up and down in a grooved frame; and in greater cases, butting gates are hung so as to shut against each other in the middle like folding doors, or to turn on a horizontal or vertical axis, by some of which a body of water is at times collected and discharged, so as to clear the mouth of the channel from obstruction. When this outfall is situated on a shifting beach, it is often advisable to protect it by a pier or jetty of piles, &c., and to remove the gravel or sand which this may accumulate as often as appears necessary, or to form a covered channel through the whole line of beach into deep water. Much may, however, be effected by the judicious position of the outfall, with respect to the currents, that it may not be warped up by the depositions from the river or sea, but rather swept clean. In dangerous cases, and exposed situations, a second valve is sometimes formed on the inside of the first; and by the admission of a certain portion of water between them, the pressure on the exterior one is diminished. A good instance may be seen at Lossiemouth, in Morayshire, upon the great cut which has drained the Loch of Spynie. Many other precautions are requisite for the security of these sluices; but we cannot particularize them here.

When there is no natural outfall, the waters are lifted over the bank by machinery of various descriptions. The marsh-mill of the eastern fens, is a windmill, having a body of brick about 20 feet high. The axle of the sails, by two bevel wheels, communicates motion to an upright shaft, on the lower end of which a horizontal wheel moves another vertical wheel; on the outer end of the axis of this last, is a small water-wheel, similar to that of an undershot mill, working in a case of wood or stone, and with a valve drain at the head; the little water-wheel is thus driven against the fall, and throws up the water three or four feet, which permits its escape into the river. When a fall of water can be had, a very simple marsh-mill is formed by two water-wheels, on one axle of which one is driven by the fall of water, and the other acts, as usual, in lifting the water over the bank. The current of the river is sometimes used as the moving power; and though this is not advisable, great benefit may, in many cases, be derived from the rise and fall of the tide.

If the drains fall freely into the brook, the brook into the river, and that into the sea, nothing farther need be wished for; but it often happens that one or other of these is so obstructed, as to cause injury to the lands above. The new channel, or operations for the amendment of the old, must be frequently executed on property which has no immediate prospect of advantage from the undertaking. Hence it becomes necessary to have legal authority for this purpose, and to form commissions of drainage, which, in order to do their business with effect, should have cognizance of the entire river or district, and of all the baron of land which is drained thereby; and they should have power to assess individuals or communities, according to the benefit received by the improvements which they effect. Romney Marsh is governed by 24 jurats and a common bailiff. If any person should refuse or neglect to make necessary repairs, the bailiff does them at the oversight of the jurats, and charges double on the defaulter; the surplus goes to the fund for banks and repairs; the defaulter may be distrained for the same within the marsh.

The draining of embanked land by steam power, has, of late years, been extensively and with vast advantage practised in the fens of Lincolnshire, Cambridgeshire, and Bedfordshire. A steam-engine of ten horse power has been found sufficient to drain an area of 1,000 acres; and it is required to work in the aggregate four months in the year, at intervals and during periods varying with the season and with the nature of the weather. An eminent advantage of drainage by steam power is that it maintains the fullest control over the degree of moisture in the soil, and can both clear away water to an equal lowness during the prevalence of rains, and admit of the sluices being opened and water brought in during the prevalence of drought. The first cost of the buildings and machinery varies with the nature of the land, but generally amounts to about 20s. per acre; and the current yearly cost probably averages about 2s. 6d. per acre. An engine of 40 horse power costs about £4,000, and is capable of draining 4,000 acres of surface. In many parts of the fens, land has been purchased for from £10 to £20 per acre, and then been so much improved by drainage as to become worth from £60 to £70 per acre. In 1839, two engines of respectively 60 and 80 horse power were at work on Deeping Fen, near Spalding, in Lincolnshire, a district of 25,000 acres; an engine of 40 horse power, in March West Fen, in Cambridgeshire, a district of 3,600 acres; an engine of 40 horse power, in Misserton Moss and Everton and Graingley Cars, a district of about 6,000 acres; two engines of respectively 30 and 40 horse power, and a few old windmills, in Littleport Fen, near Ely, a district of about 28,000 acres; an engine of 60 horse power, in Middle Fen, near Soham, in Cambridgeshire, a district of about 7,000 acres; an engine of 60 horse power, in Waterbeach Level, between Ely and Cambridge, a district of 5,600 acres; an engine of 40 horse power, in Magdalen Fen, near Lynn in Norfolk, a district of upwards of 4,000 acres; an engine of 30 horse power, in March Fen, in Cambridgeshire, a district of 2,700 acres in the finest possible condition of drainage; an engine of 20 horse power, in Feltwell Fen, near Brandon, a district of 2,400 acres; and an engine of 40 horse power, in Soham Mere in Cambridgeshire, a tract of 1,600 acres, lying unusually low, and formerly occupied by a lake.

Strata-Draining.—Strata-draining reclaims and dries wet lands, whose wetness arises from the flowing of springs or the oozing out of subterranean waters. It far exceeds surface-draining in at once importance, intricacy, the extent of its range, and the amount of knowledge requisite for its proper execution; and it is sometimes, though ignorantly, supposed to supersede subsoil-draining, and to comprise all ulterior appliances for drying wet lands. Its simple object is to find the readiest channel by which excess of water flowing in strata beneath the soil can be carried off; and it presupposes both a general knowledge of the geognostic structure of the earth's crust, and some acquaintance, upon either investigation or good testimony, with the conformation or strata of the particular districts to be drained. It does not, as some persons stupidly imagine, find a drainage for the water of springs after they have soaked the soil and risen to the surface,—for this would be utterly useless expenditure of labour; but it detects the subterranean course or channel of the water of springs while it still flows at some distance below the soil, and there so diverts it into drains as to cut off or annihilate the springs, and prevent the water from either entering the soil or saturating the subsoil. So powerful is this method, that the detection of a single subterranean rill or feeder of springs, and the abduction of it into a single drain, may, in some instances, completely dry a comparatively large extent of wet and spouty land. Strata-draining, in fact, constitutes one of the most beautiful and important applications of the doctrine of hydraulics; and it is, at the same time, capable of being exhibited to intelligent farmers within the limits of a few general principles.

A frequent and very obvious case of wetness from springs occurs in shallow moss or upland bog, from what some writers have denominated "descending waters." *Plate XXXIV. Fig.* 1 represents a plan and section of a case of this kind. AB is a bed of deep clay, extending from the brook at A, back under the hill DE. CD is a bed of sand or open stratum covering the clay, and is covered in its turn by the different porous strata forming the hill or bank CDE. These strata imbibing the rain-water which falls on the hill, allow them to descend until they reach the line CD, where their farther progress in that way is stopped by the bed of clay BA. They accordingly accumulate in the sand, until the increasing pressure forces them through the different pores and fissures in the horizontal direction DC, and they issue at C *c*, the foot of the porous bank, in springs of pure water, which run forward in rills to the brook A *a*, which, if an open channel is preserved for them, are not likely to do much injury to the farmer. But it usually happens, that the edges of the porous strata EC, have been worn and broken down by the vicissitudes of weather or other causes, and their rubbish or detritus, carried forward over the low ground CA, *c a*, forms a porous soil over the clay bottom. In this case, the water which issues at the springs C *c*, instead of passing off in rills, soaks into the porous soil, and keeps it constantly drenched with wet, so as often to injure a great extent of ground below, especially if the subsoil be shallow or retentive, as is commonly the case with lands not ameliorated by cultivation. Many millions of acres in the upland countries of these kingdoms are still in this condition, their surface covered with peat moss or bog, which nevertheless might be drained at an expense inconceivably small.

The remedy is obvious and simple. Proceed to the upper line of wet ground, and examine if the springs there are flowing as abundantly as those below; if that be the case, you may conclude that the water is delivered by the "cropping out" of a bed of sand, gravel, or open rock, over a bed of clay or other close substance, at that place, and the lower patches are merely the overflow from thence; ascend to the level of a yard or so higher than the springs: you must then be in the open stratum. Cut down a ditch, until you penetrate some way, a foot or more, into the solid bed or close substance; you will then perceive the water oozing from the soil above, and dropping into the trench which you have cut in the clay; continue the trench horizontally along the line of springs, making sure at all times to cross-cut the watery stratum: in this trench put a proper hollow drain or conduit, fit to convey the quantity of water, or if it be but short, you may fill it with stone; and it will not be unadvisable to build up a water-tight partition of the clay on the lower side, so as to prevent the water from overflowing the drain, and passing again into the soil below in wet seasons. Fill up the rest of the drain with stones or the porous soil; all the spare earth must be put on the lower side. From this catch-water drain there must be, in convenient places, tail drains to convey the water to the nearest brook. It is most advisable to make the fences of the fields answer this purpose; for as the slope is sometimes considerable, these drains must generally be left open, lest they should cut their beds, and burst. But a drain may be made at the level of the catch-water, and brought out under cover until it reach the surface, along which it may then be conveyed as an open rill.

In carrying the catch-water drain along the line of springs, it may sometimes happen that springs appear above the level at which we are proceeding, in consequence either of a dislocation of the stratum, or by being in a small bay or glen, and

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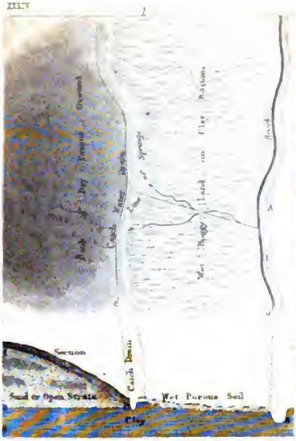

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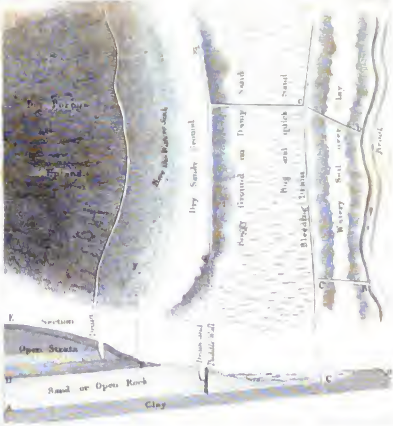

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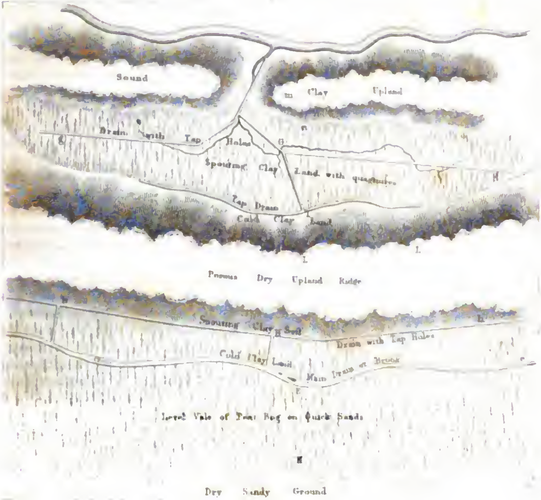

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that it would require very deep cutting to bring it into these springs on the same level. In such cases the drain may be carried across the hay, care being taken, if the soil through which it proceeds be porous, to prevent the water from escaping; for it is evident, that, if we form a clear channel along the lower parts of the sand, the water will be so far drawn off thereby as to drain all springs on a higher level which have their origin in the same stratum. But in case the bay or glen thus left out should become watery in moist seasons, a little horse-shoe drain should be run round it, upon the same principles, and should deliver its waters into the general catch-water at each end. This little catch-water having a greater slope, might carry stuff into and choke the greater one, unless proper precautions be taken. But the same measure will by no means answer in the event of our finding the sand stratum take a dip, or run out below the level of our catch-water. In such a case, it becomes necessary either to make an entirely separate catch-water round this lower tail, or to cut down across the porous bed into the solid floor, and bring up a regular puddle wall from thence to the surface.

When the upper waters are thus cut off, the grounds beneath, deprived of the sources that supplied them with perpetual moisture, may be expected in a short time to become dry, as the water which they retain gradually passes away. In order to accelerate this operation, and at the same time to have an opportunity of cutting off any lower springs that may exist in the wet surface, it may be proper to draw other drains, parallel to and of the same description with the former, at some distance down the slope. And it must be evident, that where there are various strata of sand and clay alternating, each of them will produce, beneath it, similar effects, which must require to be obviated by the same mode of proceeding.

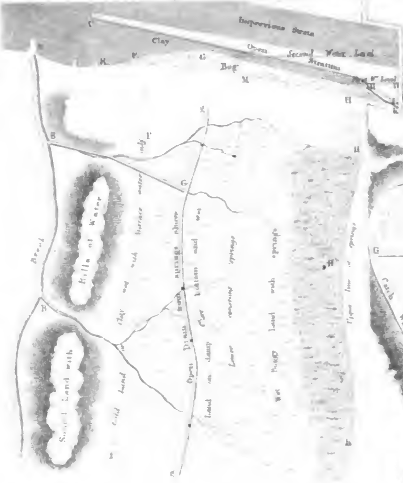
The declivity of the surface is frequently so little different from that of the strata, that a bed of sand, as DC, instead of ending abruptly, as in *Fig.* 1, may continue along the surface for a considerable extent before the inferior layer of clay crop out, or become distinguishable. Thus, in *Fig.* 2, the bed of sandstone DC, which comes from under the hill EDF, continues to run along the surface from F to C, and is not entirely lost until we find the clay at C rising or cropping out from beneath. The upper part of this stratum decomposed by the weather, forms a sandy soil throughout the space from F to C, which having an open substratum, will, in general, be friable and dry, and if covered with a rich loam, will form a peculiarly valuable soil, well-fitted for the turnip husbandry. If the quantity of water which sinks into this porous hed be tolerably uniform, and the bed of sand be deep, the moisture will never rise so high as to injure vegetation. But if it be so circumstanced that a considerable quantity of upper waters, during great rains, sink into and are absorbed by this bed of sand, then the difficulty of transmitting such a quantity will make the water rise higher in the soil, and though the upper parts, as at F, may be dry, the lower, towards C, will be gorged to the surface, and the water will ooze out of it in peering springs, forming a field there of damp sand, the most worthless that the farmer can possess.

In this case, the first subject of inquiry is, whether there be not at the tail of the sand an obstruction, such as the clay C, rising up and forming a kind of dam against the water lodged in the sand. If that be the case, let a drain be cut through the clay, and at the level of the bottom of the sand, or somewhat lower, as CB. Then along the tail of the sand form a drain CE, which, giving free emission to the waters within, will allow them to sink to that level, so as not to be injurious. If this operation has not a sufficient effect, it must be owing to the pores of the sand bed not being sufficiently open to admit of the water passing with freedom. In that case, carry up the bleeding drain into the sand, giving it branches on either side, which, by enlarging the surface of emission, may make amends for the retentiveness of the soil. But in such cases, it is often worthy of inquiry, whether it might not be better to cut off this load of upper waters before they descend into and injure the field in question; and that, either by leading away the sources from which they are derived, or by forming a dam against them at the upper margin of the field so as to bring them to the surface, and in that way not only protect the lower field, but obtain a useful supply of water for other purposes. In this way (*Fig.* 2) a ditch or trench is cut at G, being the uppermost part that appears damp in the wettest seasons, and is carried down through the whole depth of the sandy stratum into the solid clay below. If it is then formed into a drain in the usual way, the water from above will be completely intercepted; but, independent of the first cost, the expense of keeping such a drain in order would be very great, the depth in such a case being considerable. Another expedient that occurs, is to fill up the trench, thus formed, with a regular puddle wall, or partition of clay and gravel, loamy earth, or black raw peat moss, wrought with water to near the surface, behind which the water, if properly intercepted, must rise as behind a dam; and when we have it within two or three feet of the surface, a drain may be formed in the usual way, by which the superfluous water is led to a proper outlet, and which in case of need is easily accessible. By this means the upper part of the field is so far drained, as to have an outlet two feet lower than before, and we acquire such a command of the water, that it may easily be kept up to its original level, while the lower parts, which were formerly of the nature of quicksand, and covered by morass, are entirely protected from upper waters, and have their proper waters drawn off by the bleeding drain *c c*, as before. Where the overlying strata EF are of an impervious nature, the wetness of the sand may be, in a great measure, owing to the surface waters of a great extent of sloping ground descending over the surface EF, and being absorbed at F into the sand. In this case, it is evident that these surface waters may be intercepted by a shallow drain, on the retentive soil above F, and led away to an outlet before they descend into the sand. It is equally evident, that we must be careful not to cut the sand in this drain, or, wherever that is unavoidable, that we line the trench, so as to prevent the water from sinking away; yet in this case, especially if the uplands be in tillage, the drain will soon puddle itself up, and be sufficiently retentive even over the sand.

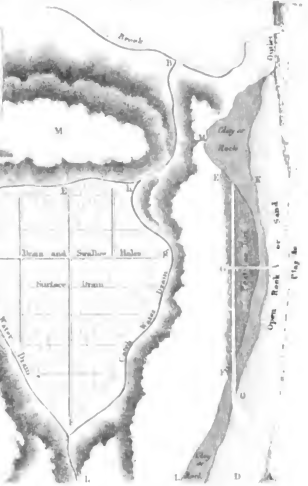
The next case for consideration is, that where the stratum of sand, or other porous matter which conveys the water, dipping faster than the surface of the ground, does not crop out, or appear at the lower edge, but runs forward under the surface, and is covered by a layer of clayey matter. *Fig*. 3, *Plate XXXV.* exhibits a case of this kind, where the watery stratum DC descending from the porous upland DKL, having no outlet at the point *c* is covered by the retentive clay BEFG, extending back to H. In this situation, the water finding no outlet, will accumulate in the stratum DC, and be pent up as in a vessel, until it rise to the upper edge of the covering, and flow over as at H. Now, this level of the outlet being considerably higher than the surface of the covering of clay below, it is plain that there must be a strong pressure upwards against the bottom of the clay, insomuch that, if a pipe was put down at G or E, to reach the sand, the water ought to rise in it to the level of the fountain H. If the bed of clay, as from C to F, be of sufficient depth and tenacity to resist this pressure, the soil on the surface will be no way incommoded; but if the covering be anywhere weak or thin, as from G to H, the head of water pressing against it will force some of the weaker places to give way, when it will burst out, and form a spring as at MM, and the water will immediately subside; and should this not be sufficient for the discharge of the whole in wet seasons, the water will again rise, so as to run also at other higher and higher openings, which after some dry weather will cease again, though the lower may still continue running. The upper level of the water will never subside so low as the spring MM, though it may remain very little above it, since at least some force will be required to press the water through the obstructions in the sand. From this cause, the ground from K to H, though of an absorbent nature, is frequently retained in a state of wetness, similar to that at CG, *Fig*. 2, on account of the moisture standing high in the subsoil, and, if left to nature, will be soon covered with moss. Again, where the texture of the clay covering is sufficiently strong to prevent springs from bursting out, yet the water will squeeze through all the pores and crannies, so as to form a field of spouty clay soil, producing only rushes, or other aquatic herbage, or brushwood, as from H to G. Where the depth of clay is so great as to prevent the oozing from being of much consequence, yet the water standing high in the subsoil, forms a field of cold, damp, clay land, as from M to F, and F to E, liable at the same time to be injured by the surface water from the springs above. In this situation, the cure is to form a drain in the neighbourhood of the lowest springs, and at such a level that the water which runs in it may be so much below them, as to leave the land dry. This ditch must be sunk down in various places, so as to tap the inferior watery stratum; upon doing which, the water lodged there will issue out in abundance, and flow along the drain; and having now found a lower outlet than the former springs by which it issued, these will quickly fall away and dry up; nay, if the stratum be of great extent, the same effect may extend to several boggy lands in the neighbourhood, and to appearance altogether unconnected with the first. The height of the confined water being now diminished, the pressure upwards against the cover will cease, and this being the only cause of injury, a radical cure will be effected. But no hollow subsoil draining could have had this effect, although the land might be somewhat relieved thereby, in many instances, especially if the drains should anywhere touch the stratum of gravel or sand in which the water was contained; neither would any benefit be derived from a catch-water drain, made at H or K, as in the last case; or even if we could sink down through the whole mass of sand, and bring up a puddle wall from the firm clay, would it be effectual, for such a dam exists, in fact, already in the covering of clay, BGH; and though we cut off most part of the supply thereby, the water in the bed of sand HC is not removed; the spring M, which still delivers the little water that may insinuate itself, may be greatly weakened, or even cease to overflow, but the hydrostatic pressure against all the lower subsoil will still remain as before. We mention this the rather, that the unexperienced drainer may be on his guard, and not proceed to work until he is well assured of the nature of the case before him; for the mode of proceeding in one of these cases would be altogether useless in any of the others.

Having brought up the outfall, or tail drain BG, and formed the tap drain *gGg* along the lower springs, our next operation is to open a communication with the watery stratum below, if that has not already been effected in digging the tap drain. Now, as a few passages will be sufficient to emit all the water, provided their area exceed that of all the springs, there can be

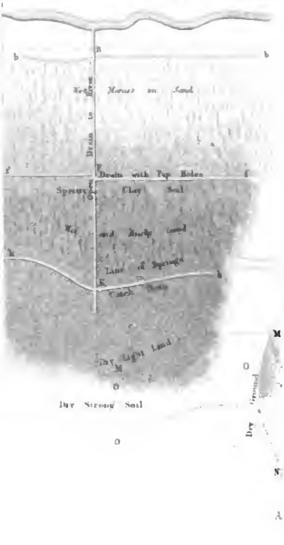
3


Impervious Strata
Clay
Open
Second Water Land
Stratum
First Wr. Land
Bog
Road
Hills of Water
Clay wet with surface water only
Open Drain with springs above
Land on damp Clay bottom and wet
Lower receives springs
Wet Boggy Land with springs
Upper line of Springs
Sound Land with
Solid land
A
B
C
D
E
F
G
H
K
M

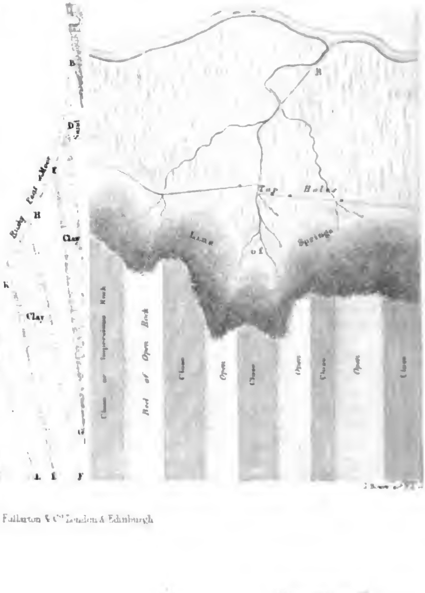
5


Brook
Outlet
M
Clay or Rock
Drain and Swallow Holes
Surface Drain
Catch Water Drain
Catch Water Drain
Loam or Rock or Sand
Open Rock or Sand
Clay &c
Clay or Rock
A
B
D
E
F
G
H
K
L

6


Mosses on Sand
Drain
Drain with Tap Holes
Springs
Clay Soil
Wet and Rocky Land
Line of Springs
Catch Drain
Dry Light Land
Dry Strong Soil
B
b
F
f
K
k
M
O

7


Tap Holes
Line of Springs
Close or Impervious Rock
Bed of Open Rock
Close
Open
Close
Open
Close
Open
Close
Sand
Rocky Coal Measures
Clay
Clay
Dry Ground
B
D
F
H
K
M
N
L
I
F

no necessity for sinking all the tap drain to that depth. Small pits may be made at convenient distances; and, to prevent them from choking, they may be filled with stones, dried peat, or the like, through which the water will rise freely. But, in general, unless where the stratum to be pierced is very stony, and even in that case if it be deep, it is much easier, and less expensive, to make use of the boring auger, with which holes are to be made at every few yards in the bottom, or on one side of the drain, down through the retentive covering, until the stratum below is tapped, and the water rises in the bore, and flows along the drain made in the upper clay. See the article AUGER.

In boring or forming pits for tap drains, it is not necessary to put them down in the quagmire; for that can seldom be done with effect, the stuff closing upon them so speedily. It is better to have them in the firm ground, as near as possible, especially at the commencement. After the water has been tapped by these, the quaggy ground will subside, and get firm; enabling us to prolong the drain, if need be, and to sink new pits or bores in case the stratum containing the water should be interrupted. The most convenient place, without doubt, is that where the stratum approaches nearest to the drain. The bore *z*, which is put down near the tail of the sand, is not more useful than the bore G at the same level; while a bore at *y*, which passes the tail of the sand, can be of no benefit whatever. In general, immediately over the watery bed there is a stratum of tight clay mixed with stones, of great firmness, under three or four feet of quaggy ground. This has often deceived the inexperienced drainer, by leading him to think he had arrived at a sound bottom. This is a good situation for laying the conduit, or sough of the drain, if the level of the outlet admits of it; but it must be pierced by the borer, or pick and spade, without regarding the trivial springs that appear therein, until the reservoir be arrived at. By a careful examination of the adjoining ground, it is sometimes possible to say at what depth this may be found; but, in general, the rule is, to go down till the water rise immediately on withdrawing the auger. Mr. Elkington has bored thirty feet before the water flowed plentifully. but from ten to fifteen feet is more usual.

Fig. 4, *Plate XXXIV.* explains some accidents that often occur in this kind of draining, and, at the same time, shows how the same principles may be applied to other cases, and especially the digging of wells. DC is a stratum of sand, resting on a bed of clay or solid rock, and extending under the hill L: it only bassets or crops in the level valley from E to K, where it forms the bottom of a peat bog or moss, which has risen over it, on account of the valley having little declivity, so that water stands constantly in the sandy subsoil. BE is a bed of clay lying over the sand, and likewise running under the hill; beyond which it crops out at E. This bed of clay in the vale, from C to F, is but thin, so that it there forms a bottom of spouting clay soil, with springs and quagmires, owing to the pressure of the water in the sand bed below. The hill L is composed of gravel and sand; but, on the right side at F, this is overlapped by a thick cover of clay to the summit; on the left side also, at H, there is a cover of clay, which is much thinner, and does not extend to the summit,—it abounds in springs, forming a bank of spouting clay soil with rushes. Each of these covers of clay unites with the bed BE at the foot of the hill, where a field of cold clay land is found on either side.

Now, the improvement of this ground is begun by the proprietor on the left side, who proposes to drain the moss KE by bleeding the sand; for this purpose, he leads up the main drain E *e* along the tail of the sand, where it meets the clay. He finds it necessary to sink it only by little and little, so that the sand may have time to drain and get firm, otherwise the sides run in upon him. He finds it necessary also to clear the whole length of the drain to the outlet, before sinking any part lower than another; for, after getting down an inch or two, the sand appears as fluid as water. In this operation he succeeds to a certain degree; and it is perceived, that the run of water from the valley, by the drain E, is greater than it had ever been before; and at the same time, the quaggy bottom on the right of the hill has been somewhat benefited, and the springs at G give rather less water. The reason is obvious; a part of the supply is diverted, and the fountain-head lowered. Were he to persevere until he came to the bottom of the sand, the land at G would be drained, for it is on a higher level; but this proprietor has no interest in so doing. He next proposes to find water at K, in the morass, for which he sinks readily in the sand to the level of the drain E. Below that is a quicksand, which can only be excavated by dredging under water. His next operation is to drain the springy bank below H, and, at the same time, to get water at a higher level, he makes a tap drain H *h*, and bores in the bottom, until he cuts the open gravel of LHF, which furnishes a supply, and relieves his ground.

Suppose now the proprietor on the right wishing, in like manner, for a supply of water, makes a tap-drain on his side, along the hill, as at F, but somewhat lower than the level of H, and bores into the under stratum; the water of the hill HLF will now flow away at F, and the drain H *h* will be dry; but the land round H will be somewhat better drained than before. Suppose the proprietor at H still wanting a supply there, should bore down through the stratum of clay EB, and into the sand DC: instead of raising any water by that means, the whole supply of HLF will now run down through the bores at H into the sand DC, and pass away by the drain E *e;* so that the ditch F *f* will in its turn be dry.

Nevertheless a well or pump at F will always find water in the tail of the bason HLF; and if the bore at H be below the level of the drain E, the supply may even be more permanent than before. since it communicates with the great bed DC.

Lastly, suppose that the wet bottom on the right hand is to be drained; for which purpose the tap drain G*g* is laid out, and bores sunk into the sand DC. The water will now rise up from the sand, and relieve the quaggy clay above: the springs in the bottom will cease, and, what may appear still more remarkable, the main drain E*e* beyond the hill will ebb dry, and the quicksand around will become firm and dry, as low as the level AGB of the tap drain. The well at K may now be sunk without difficulty; but no water will be found until we arrive at the clay (above the level before-mentioned), and even then only by cutting a reservoir in the clay, to receive a part of the waters which trickle along its surface through the bottom of the sand. No overflowing well can now be made in that situation, even should there be strata containing water to a higher level below, which might be bored into, unless a close steining or casing be carried up through the sand bed DC, to prevent its ebbing away by that channel through the drain G; but, before tapping at G, if we had inserted a bore at *m*, which is below the level of E, we would have had an overflowing well on the top of a hill; and again, if the stratum of clay at H were not yet cut through, we would have at the same time another overflowing spring at F, which would appear to be the hill from which the fountain at *m* was derived. We have seen instances of this kind in natural springs.

Similar effects take place frequently in the drainage of mines; and when these are level free, they may be frequently applied to the purpose of draining the lands above, by boring down at H, or boring upwards from the mine. But where the mine is drained by artificial means, as pumps, or the like, it becomes of the greatest consequence to cut off and remove all supplies of water that may enter from above.

Suppose, for example, that DC were a bed of coal, or other mineral, drained artificially at K, and that a shaft were to be sunk at H, it would be necessary to pass through the open stratum in the hill HLF: if this were a quicksand, abounding in water, it might be very difficult to be effected; and it would be necessary to introduce piece after piece of curb timber around the shaft, to prevent the sand from running. Even if we should succeed in getting down, the water would descend through these timbers so abundantly, as to increase greatly the water on the engine at K, and might even drown the mine. The remedy, in that case, is to surround the leaky part of the shaft H with an inner casing of timber, and a puddle wall of clay, &c., behind it, and to unite this puddle wall with the beds of clay both above and below. The mine being then relieved of foreign water, will be restored to its original state, and will come again under the power of the engine. But suppose the bed EB not to be so completely retentive, but that water may penetrate through it when the lower beds are laid dry, especially if it be pressed by a great force, as the water accumulating in the hill LHF, then it may be still possible to relieve it from that pressure, by tapping, for example, at H or F, so as to lower the head of water in the reservoir, which will not then be able to penetrate through the bed EB, or, at least, not so abundantly, and the engine at K will be greatly relieved. Similar effects will also be produced, by having a catch-water dam, or puddle wall, to lead off the water, which would otherwise be absorbed on the upper side of K, towards the crop of the strata, as described in *Figs.* 1 and 2. A leaky stratum may be covered or lined with puddle, and secured in a similar way.

Suppose again, that the proprietor on the right hand at B intends to work his part of the bed of coal, and to drain with engines by the shafts G or *m*. But that the proprietor A, who will be equally or more benefited, and whose engine at K will thereby become unnecessary, refuses to assist him. Then B, having no other resource, places a powerful engine at G or *m*, and sinks to the coal; but he takes the precaution, after driving his engine level along the coal as low as he can reach, to make up the lower side of it with a puddle wall of clay, &c. In like manner, he cuts out the coal along all the boundary of his property towards the basset, and replaces the excavation by water-tight materials, so that all the water which formerly flowed in upon him from the basset of the strata is now puddled off; and he finds the drainage of the remainder can be effected by much less power, than was necessary for his first engine at G. The proprietor A, however, whose coal at first was laid level free, is now perhaps worse off than before, since he is deprived of the benefit of springs, that may have flowed at G, below the level of part of his coal; but should there be absorbent strata in that direction, and above his level, he will be benefited by the puddling. The beds of coal, and other minerals, are frequently traversed by natural partitions of water-tight matter, which are of great benefit in the drainage of the mines. It is surprising how thin the partitions are, which resist great depths of water in this way; and which, when they are incautiously broke through, are productive of great difficulty, and even danger; so that it is advisable, in all dubious cases, to make constant use of the boring iron, to discover them, as the hole which is thereby made may be easily stopped up in case of need.

Puddling is also used in the digging of wells, to keep out salt or mineral springs, which may flow into the pit before the stratum containing wholesome water is reached; and it is also used in mining for protection against a stratum, which emits hydrogen or inflammable air. A remarkable instance of the former is related in the Philosophical Transactions, vol. lxxiv., where an account is given of sinking a well at Sheerness. When similar circumstances occur in boring for water, the remedy is to introduce a pipe of wood or metal into the bore, which admits the water only at the lower end. Nearly the same advantage is sometimes obtained, by excavating the hole a little wider in such a stratum, and pressing in clay, which the water in the bore keeps from being displaced. If the water in the spring, which is formed at G, were confined by a surrounding wall, it might be made to rise to the level of the original outlet at E; and a pipe might be laid from thence to the top of the bank at *m*, so as to deliver water without sinking a shaft there, or boring for it; for in neither of these cases would it rise higher than the level of G, if previously tapped there. Or the same water, if abundant, may be applied to the working of machinery, when a fall is in this way obtained for it. A very pretty instance of this occurs at Cong, in the west of Ireland, where the waters of the great Lough Mask, issuing in a magnificent fountain, are dammed up by a wall, and immediately applied to the turning of mills.

The effect of the bore at H in this Figure, shows how wet grounds may sometimes be drained by letting down the water into an open stratum below them. The most useful case of this kind, is that of a land-locked bottom, into which the cutting of a main drain through the bank would be attended with very great expense. *Plate XXXV. Fig.* 5, represents a case of this kind, where the bog bottom, EGF*g*, is shut in by the high ground L and M. These grounds, though composed of open rock or gravel, have a cover of clay at least on the side next the hollow, through which the water cannot descend, thereby forming a lake, or at least it descends very slowly, so that the bottom is frequently under water, by which means it is converted into a peat-bog or moss, and gradually fills up with this vegetable matter, until by this means, and the water which it absorbs, the surface swells so far, as to throw the superfluous water off by means of the brook *g h* B; while the middle becomes a deep hobbling bog, inaccessible to man or beast, except when the sun and wind, by evaporating part of the moisture, have formed a thin crust on the surface.

The obvious remedy is, to lower the outlet, or drive a deep cut, or an underground tunnel, through the ground M, into the lower part of the bason. But this may be too expensive an operation. Examine whether there is not an open stratum below the bason of clay, or one which, if it should be glutted with water, may yet be tapped somewhere, as at B; then, in that case, open a main drain through the middle of the bog, with cross and surface drains, to intercept and deliver the water into the main. In this main there must be auger holes sunk down into the open stratum; these will swallow up and carry off the water. Care must be taken to prevent the moss and clay from finding its way into the swallow holes, which would soon choke them. For this purpose, a filter of stones, or the like, must be placed round them; or a pipe made of wood, slates, &c., to rise something above the bottom of the main drain, which thus becomes a cess-pool. And that they may be as little as possible loaded with foreign waters, form a catch-water round all the bottom in the retentive cover, which may deliver the surface water of the neighbouring grounds, by the original lowest outlet *g h*. The surface of the bog will subside; but as all the drains will subside with it, and the main drain most, they will still continue effective. It is quite unnecessary to cut such drains down to the clay bottom.—One large pit or swallow hole in the lowest part, would answer equally well for a bog of limited extent, if it could be carried down to the open stratum; and it would be less liable to choke. The main drain may be led into it; but the drainer must not expect the peat-bog to be bled by such a pit alone, without the assistance of surface drains. Swallow holes are common enough in the great bogs of Ireland, many of them of great depth and magnitude, usually in limestone rock, and they have obviously been formed after the bog had accumulated; yet they produce very little effect, even very near them, though they may sometimes save expense in cutting drains.

The next case for our notice, is that of grounds lying on the crop or basset of the strata, instead of being towards the dip; the most remarkable effect of which is the alternate beds of wet and dry soil thereby produced. — *Fig.* 6. explains this situation, showing a hollow in which there are alternate beds of sand and clay, or the like, dipping into the hill. This may be considered as the dry side of the hill, and will, in general, be found so, provided the different beds of sand have any lower outlet; for of course all the water they imbibe will run off by that; but if not, then the water, falling from the summit O, will sink into the bed of sand KMLI, and fill it up like a dish, until it run over the lip at K; then, after keeping the surface K wet by soaking along the soil, it will subside into the land FHGE. We may suppose a little of the soil worn down from KH, to form a cover at the lower edge of HE forming a spouting clay. The water running over this, and wetting the clay bed ED, subsides into the sand DB, which, being nearly level at top, it completely fills.—Lead up a drain across the different strata at the lowest place, notching it pretty deep into the upper edge of the clay; and then the water running off from the sands at lower levels, will not afterwards overflow. If it is necessary, carry a catch-water *k k* along the tail of the upper sand, which, cutting off the first supply, may perhaps cure the whole. In the drain, at F, where the tail of the sand has a covering of clay, sink tap holes in it; the lower sand DB, which is damp, must be bled by a deep drain at B, so that this case is reduced to a modification of the former ones. It is sometimes unnecessary to continue the drain through the sand, since that absorbs the water readily; and it may be collected by an arm, on either side at the lower edge, into the next piece of drain which crosses the clay.

Fig. 7. shows the case where the strata are vertical, or nearly so, and have their edges in the face of the declivity. The water will here subside through each of the open strata, and issue at its lower corner as a single spring; of course there will be a line of these springs along the foot of every declivity, which are altogether unconnected with each other; and as the foot of the declivity will be covered to some height with the rubbish of the strata above, quicksands and quagmires may be formed thereby. The remedy is to bring up a cut for a tail drain BA, to run a drain along under the level of the springs, and then to make small cuts into every spring, all at a proper level in the subsoil; or if the ground be spouty below them, to sink a tap hole below each spring in the direction of the stratum.

These different cases comprehend only the simpler situations which are likely to occur in the practice of strata-draining; but, if well understood, they will be sufficient to direct the operations required for the most complicated. It sometimes happens, that all the different kinds are required in one field; at other times, this great complication is only apparent, as in *Figs.* 3 and 4, and one drain, judiciously directed, will do more than a great number run merely at random without previous investigation. The first thing required is a careful examination of the strata. The inclination of the strata must also be examined, to judge how they are connected with the given site, and how a drain or bore may be directed to reach the spring. It is proper, therefore, to examine all places where the strata have been laid bare, as in cliffs, river beds, wells, ditches, quarries, &c. in the neighbourhood. Where nothing of that kind occurs, the boring irons must be applied for the purpose, or pits sunk in the soil. If the water rises in these, the evil and its cure may be discovered at once, and a drain opened; but it would be very injudicious to do so without such previous investigation. The figure of the ground must also be considered, as that will lead to a knowledge of the place where the watery bed bursts out, or is most accessible, and where drains may be most advisably placed. The probable supply of water may also be known in this way. The spirit level is used for laying out the direction of the drains, and calculating the expense of cutting them. The height of water in the interior strata may also be known thereby, by levelling from the neighbouring springs and wells.

Subsoil-Draining.—Subsoil-draining is the underground removal from absorbent soils or subsoils of stagnating or saturating surface-water, whether derived from dews, from snows, or from rains. It effects, for a greater or less depth of the soil, or of both soil and subsoil, the same abduction of moisture which surface-draining effects for the surface; and is designed to reduce stiff, cold, retentive lands into mechanical and chemical conditions similar in kindliness, warmth, porosity, and manurial decomposition to those of naturally light, friable, and grateful loams. It has a greatly more diversified, expansive, and important range of application, and a vastly more varied and powerful evolution of both mechanical and chemical forces, than the two other classes of draining combined; and, in a loose view, it has as its peculiar province all the wide and fair dominion of the strong and deep kinds of arable land, while strata-draining has only arable hills, spouty bogs, and the inferior portions of arable plains, and surface-draining has only fens, land-locked hollows, and barbarously-managed fields. Yet subsoil-draining sometimes conjoins itself, in a greater or less degree, with the other classes; it comprises within itself a vast diversity of method, from covered hollow draining which differs but slightly from surface-draining, to exceedingly deep tile-pipe draining, which seems to address the astonishment and credulity of many farmers rather than their belief; and it has, of late years, suffered considerable complication, partly from the rapid progress of agricultural science, partly from discrepant testimony respecting the results of experience, and partly from conflict of theory as to direction, depth, and frequency of drains, and as to some other elements in its modes of action. Our conscious freedom from all bias, therefore, combined with our wish to give a comprehensive view of the whole subject, and to enable every reader to judge for himself, will oblige us to bring together in this section methods good, bad, and indifferent,—general and local,—old, newish, and altogether recent.

Distinctive names of the several methods are in some instances sufficiently descriptive and correct to afford a little assistance; but in others, they are either so ambiguous or so inappropriate as to be worse than useless. Even the generic designation of the whole class of methods is unsettled and multifarious. Some persons call all the class of drainages for the underground withdrawal of rain and snow water surface-draining, in allusion to its abduction of water from the surface, and so confound it with the class of methods for withdrawing water along the surface; others call it hollow-draining, in contradistinction to draining by means of open drains, and so restrict it to such of its methods as employ only ducts or conduits; others call it frequent-draining, in allusion to the numerousness of its drains, and so suggest the utterly false idea that the construction of its drains requires to be often repeated; others call it parallel-draining, in allusion to the general parallel position of its drains, and so exclude from it such methods as do not require parallelism; others call it deep-draining, in allusion to its tendency to dry the soil from surface to base, and so exclude from it its shallow methods, and confound its name with an old and by no means obsolete designation of strata-draining; others call it furrow-draining, in allusion to the older methods of it having their drains almost always placed along the furrows, and so exclude from view its very power of annihilating the ridge-and-furrow system; and others call it thorough-draining, in allusion to its design of rendering the soil thoroughly dry, and so restrict it to perfectly effective applications of only its best methods. When men speak of the underground abduction of surface-water only as it is wished to be or as it ought to be, they may properly enough call it thorough-draining; but when they speak of it as it is, or make comprehensive allusion to defective as well as to perfectly efficient methods, they will avoid confusion by applying to it some such general designation as subsoil-draining.

The proper draining of absorbent moss, or of the several kinds of bog which owe all their wetness to the retention of surface water, totally differs in principle from both the surface-draining of land-locked morass and the strata-draining of spouty and springy bogs, and must be regarded as a variety, though a very simple one, of subsoil-draining. The chief operation, in a long-established method of it, is to cut down the fibrous turf to a proper depth, and then with the feather-edged peat-spade, or slave, to take out a groove in the bottom. This operation being performed in summer, the shoulders will dry, and become firm; and a part of the turf extracted being dried into peats, they may be placed over the groove, resting on the two shoulders, and the trench filled up with the broken stuff, which will be found to transmit the water freely. In the schistose countries, a slate may be laid in that way over the groove, and will be very durable. Some drains formed in this way have run freely after thirty years, although the slope was considerable,—a proof that fibrous peat moss, when kept from the sun and air, affords a good bottom for hollow drains. In excavating such drains in moss, it is not necessary to dig open the whole length of the trench; for parts of the surface may be here and there left firm, and a pipe or sewer scooped out beneath them, to admit the water to pass along. These solid parts will be very useful as bridges, and soon becoming dry and tough, will, if gravelled over, admit even heavy carriages to pass on them. In this way, when the size of the drain makes it worth while, half of the cutting may be spared.

The subsoil-draining of moorlands and light mossy soils, in the vicinity of peat bog, may be cheaply and expeditiously effected by means of pieces of dried peat in the form of draining tiles. Dried peats which happened long ago to be buried by accident in the mosses whence they were dug, are occasionally brought to light in a fresh, hard, and dry condition; some which have been used in draining operations, have, after the lapse of thirty years, been taken out of the drains solid and unimpaired; and some are said to have been boiled in the caldron of a public factory during six months without suffering either disintegration or their capacity of resisting moisture. Pieces of dried peat in the form of tiles, therefore, are supposed to be quite as fit for draining purposes as clay tiles, and only a degree or two less durable. An ingenious spade for economically and expeditiously cutting them out of native masses of bog or turbary, was invented about ten or eleven years ago by Mr. Hugh Calderwood of Blackbyres in Ayrshire; and it cuts them with so much ease and rapidity, that a farmer may cut from 2,000 to 3,000 of them in a day, and obtain them in a state of full preparation for use at one-fourth or one-fifth the cost of the same number of clay tiles. They have a semicircular groove in the same manner as clay tiles, but are far thicker and more massive in the body; they are cut out of the solid bog in as constant a series and with as little waste of material as common square peats for fuel; they are dried, and may be stacked, in the same manner as common peats; and, when used for draining, two rows of them are placed along the bottom of a narrow trench, the under row with their grooves up and serving as soles, the upper row with their grooves down and serving as covers, and both combining their grooves to form a regular and continuous cylindrical duct. The details of cutting the trenches, of their depth, their direction, their mutual distances, and the filling of them up, are capable of great variegation, but on the whole, are similar to those, afterwards to be noticed, in draining with clay-tiles.

The oldest methods of the subsoil-draining of arable land comprised merely a rude series of simple and primitive conduits, at such shallow depths, as, though beneath the reach of the skimming and scratching tillage of former times, to be within the range of the ordinary ploughing of the present, and either quite within or partly above the beds traversed by our trench-ploughings and subsoil-ploughings. Many of the old drains which have been discovered and turned up in the course of modern georgical improvements, consisted simply of small square conduits, without a sole, and with series of three flat stones for sides and cover; they appear to have been formed on the fallacious principle, that ducts situated along the surface of a retentive subsoil at the base of a porous soil are sufficient to free the latter from excessive moisture; and almost all are found in a thoroughly choked condition, and probably were speedily filled with earth by the combined action of moles and water, and became occasions of an increase of the very excess of wetness which they were designed to remedy. These paltry and mischievous apologies for drains can, of course, teach nothing to modern farmers by imitation; yet they communicate broad and important lessons by contrast and warning.

An early method of the subsoil-draining of very wet surfaces and spongy soils, proceeded on the principle of horizontally collecting water through the sides of the drains from the pores and layers of the stratum in which they were formed; and this method, notwithstanding the rudeness of its principle, is still very far from being obsolete. Its drains are simply trenches or ditches filled with such small boulders as occur in the field or moor or bog which they traverse; and they are provincially called rumbling rivers or rumbling ditches in Scotland, and French drains in Ireland. But these, though stone-filled drains, must not be supposed to possess any affinity to the deep, narrow, soil-covered, stone-filled drains of some of the most modern and improved varieties of subsoil-draining. Both their position and their principle have a character but a degree or two superior to that of mere surface-draining; and their indiscriminate repletion with stones of various hardness, shape, and size, prevents them from acting freely as conduits, and sometimes occasions portions of them to become rather dams than drains.

An interesting old instance of subsoil-draining with bricks, was discovered five or six years ago on the estate of Culhorn in Wigtonshire, and throws pleasing incidental light on the durability of modern draining with clay-tiles and tile-pipes. The brick drains were discovered during operations for redraining, and were proved by documentary evidence to have been upwards of a century old at the time of their discovery. "There was on the surface of the ground," says the discoverer's account of them, "no appearance of the old drains, and these being discovered merely at different points in the course of the new operations, the lines of them could not be followed very exactly; but one of them appeared to be cut very judiciously where the open stratum approached to the clay, or between the 'wet and the dry,' as drainers would say, about 31 inches deep, and catching a good deal of the water. The others were in a moss or bog, and carried through the low and wet ground, but at one place pointed into a strong spring under the adjoining hill, from which they received a part of the water. These last drains were also about 31 inches deep, being cut through the moss into a retentive, whitish, sandy subsoil, but were not sufficient to dry the land. Part of the drains were constructed of two bricks on edge, set asunder, and two laid lengthwise across them, leaving an opening of about 4 inches square for the water, and having no soles. One of the drains was larger, consisting of two bricks laid side by side on their beds to form a sole, with two bricks built on bed at each side resting on the solid ground, having covers of broad stones, and packed on each side of this very complete opening with broken bricks. These drains had run out upon low, marshy bogs, and had been allowed to choke up at the mouths; but, on being opened up, the water in the whole drains runs quite freely; and, on examining them at different places in their course, I found that the bricks on edge upon a sandy clay bottom, had not sunk in the least degree, nor was any sludge deposited; but the original small passage of four inches in the small as also in the large drains, was quite clear." The state of these drains shows that tiles are likely to be very durable, and have no need of a large bore; and it also evinces the necessity of having few outlets and a proper fall.

An early method of subsoil-draining, in the eastern districts of England, where stones are scarce and where many of the wet lands were covered with coppices, seems to have been to place along the bottom of a narrow trench a series of three poles, triangularly, or one along the upper side of the other two, and to fill up the trench with the earthy matter of the soil and subsoil; and this method has been continued to the present time, in the modified form of draining with billets, leafless green bushes, and various kinds of thorns and brushwood. Small billets of any kind of wood, particularly of old thorns, are well calculated for soft and peaty lands, which are unable to bear the pressure of stones; and they have been known to make good and serviceable drains of more than fifty years' duration, such as maintained their hollowness and all their powers of drying land, long after the billets themselves had crumbled away and perished; yet, except in bogs or very soft lands, most billets are liable, in the course of a few years, to choke up the water-way by the manner in which they rot, crumble, and absorb. Green willow, however, when used in a leafless state for drains, has been known, in some situations, to last for ages. Brushwood of various kinds, when used green and leafless, has also proved serviceable, both by being itself somewhat durable, and by leaving the conduits hollow, open, and unobstructed by its own decay. Common heath, especially when obtained in large and rank growth, has likewise been found a durable substance. Broom, furze, ferns, and even haulm, hop-binds, stubble, and straw-ropes, have likewise been successfully employed, and, as we shall afterwards show, are still esteemed good draining materials in some parts of England. But most woody and other vegetable substances act fully as much by leaving conduits open after they themselves perish, as by constituting conduits while they continue in a fresh condition; and they therefore require to be compactly overarched with a clayey stratum or with such kinds of other earthy matter as will form a firm and resistive ceiling to the conduits when the vegetable substances decay. Each faggot of

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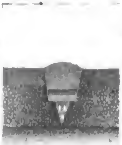

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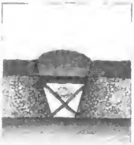

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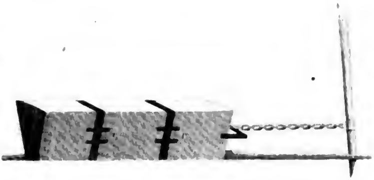

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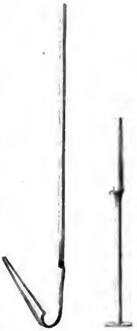

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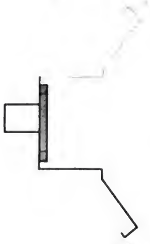

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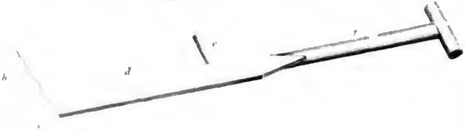

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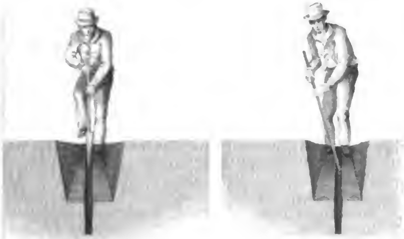

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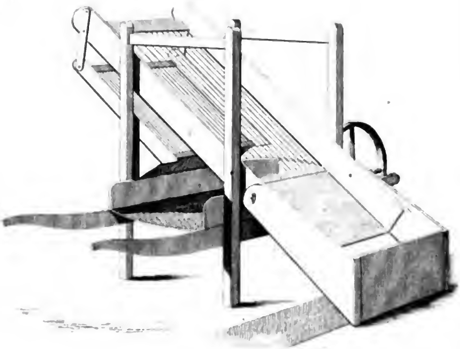

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brushwood, or bottle of straw of 120 to the load, is sufficient for three perches of drain; a covering of sod or of some substance of similar mechanical action must be put upon it to prevent the earthy matter, with which the upper part of the trench is filled, from being washed down while yet loose into the conduit or pores of the drain; immediately over this covering, the loosest and coarsest portions of the excavated earth ought to be laid; and over all should be placed the finer earth or true soil, rounded up a little to allow for shrinking. "The durability of the materials," says Sir John Sinclair, after enumerating stones, bricks, turf, wood, green bushes, blackthorn, heath, fern, furze, broom, and straw, "is of less consequence in clayey soils, than the probability of having a sufficient opening for the water to flow through; for clay sometimes forms an arch over these materials, capable of supporting the incumbent soil, and leaving a clear passage for the water below when they decay. The materials must be covered with loose straw, stubble, fern, rushes, or turf, before the mould is thrown in. The drains should be filled up as soon as possible after they are ready for that purpose, and by the most careful of the workmen. They should at any rate be completed before winter, for if exposed to frost, they are apt to crumble down." *Fig.* 8, *Plate XXXVI.* represents a clay drain filled with straw or brushwood.

A somewhat old yet complex method of forming the conduits of subsoil drains combines the use of billets with that of softer vegetable materials. The billets of wood are set on end in the drains, resting on either side alternately; and the space left between them on the upper side is filled with brushwood, the space above with straw, rushes, or green aquatic weeds, and all the higher space, as in the former method, with the excavated portions of the subsoil and the soil. *Fig.* 9, *Plate XXXVI.* shows this method of forming a drain.—Another method, or rather a variety of the preceding one, is to fix in a stick like a hoof, at the distance of every foot or so, and to lay on these the brushwood longitudinally, or to lay some stout sticks across the shoulders of the trench, and to cover this with spray and with inverted turf or sods. But a great defect of drains formed in these methods, especially as they have been usually constructed at but a small depth, is their liability to be injured by the tread of oxen or horses in ploughing.—A very different and far more feasible method of using wood, which we shall immediately notice, is to employ larch tubes as a substitute for tiles. But before dismissing the methods of draining with miscellaneous vegetable substances, let us quote the stricture upon them of our contemporary, Mr. Henry Stephens. "The recommendation of wooden tubes for the purpose of draining land," says he, "reminds me of many expedients which are practised to fill drains, among which are brushwood, thorns, trees, and even straw-ropes. With the exception of the trunks of small trees, which, when judiciously laid down in drains, may last a considerable time, it is not to be imagined that brushwood of any kind can be durable. Hence drains filled with them soon fall in. It could only be dire necessity that would induce any man to fill drains with straw twisted into ropes; and it could only have been the same cause in situations where stones were scarce, and at a time when drain-tiles were little known in Scotland, such as was the case during the late war, that could have tempted farmers to fill drains with thorns. No doubt the astringent nature of thorn wood and bark may preserve their substance from decay under ground for a considerable time; but the sinking of holes in such drains, as I have seen, were infallible symptoms of decay. Only conceive what a mess such a drain must be that is 'filled up to the height of 8 or 10 inches either with brushwood, stripped of the leaves—oak, ash, or willow-twigs being the best—and covered with long wheat straw, twisted into bands, which are put in with the hand, and afterwards forced down with the spade, care being taken,' the only case of it evinced in the whole operation, 'that none of the loose mould is allowed to go along with them. The trench is then entirely filled up with earth, the first layer of which is closely trampled down, and the remainder thrown in loosely.' [*British Husbandry*, vol. i. p. 457.] And yet such is the practice in several of the south-eastern and midland counties of England."

The method of subsoil-draining by means of larch tubes was suggested to the Highland Society about seven or eight years ago by Mr. Scott of Craigmoy in Kirkcudbrightshire, and is described by him with much clearness and minuteness in the 50th and 54th Nos. of the Society's Transactions. Larch, especially if felled in winter, and allowed to dry with the bark on, is well known to possess an extraordinary power of resisting the decomposing or rotting influence of water. The piles on which the sea-girt city of Venice rests consist of larch, and remain fresh after the lapse of centuries; and pipes of larch wood used as drains can scarcely be computed to have a less durability than from 30 to 50 years, and might probably be made quite firm and resisting for at least a century by the precautionary process of kyanising. Their grand recommendations are their availability in some districts where draining tiles, or tile-pipes, or good draining stones cannot be had, and the saving of time and labour in placing them in the trenches, and their exemption from the accidents of fracture and contusion either by the tread of cattle, the rolling of wheels, or the compression of the sole; and their grand disadvantage is the probability or almost the certainty of their everywhere costing more money than other approved draining materials. They may be constructed by various means, of various capacities of water-way, and of different shapes, either with three sides so as to be triangular, or with four equal sides so as to be square, or with two sides broad and two narrow so as to have a parallelogramic bore. But Mr. Scott recommends that they either be pierced with small holes, or be notched with small saw-cuts, or have their lower seams a little open, to admit the water,—that they be fastened with pins of ash, oak, or elm,—that they present a square of four inches outside, and have a clear water-way of two square inches inside,—and that, in constructing them, the sole be first placed on the carpenter's bench, then the side pieces upon the sole, then the top over all, and the pins be driven through top, sides, and sole with a wooden mallet. "Since writing what precedes," says Mr. Scott at the conclusion of the second of his memoirs, "I have been informed that larch and Scotch fir had been used to a considerable extent in drainage on the estate of Netherby so long as 25 or 30 years ago. 'The trees employed were thinnings of larch and Scotch fir, split down the middle, and so placed as to form a covered trough or hollow drain. The wood was not perforated, but loosely jointed, and the surface water escaped most readily.' Sir James Graham further informs me, that he has 'wood-drains still running and quite effectual, which were laid down 25 years ago. Where the run of spring water is constant, and where the wood is buried deep in the ground, these drains will not perish, and will continue useful for a long time.' Those, however, which were near the surface, and intended to carry off rain water, thus being alternately wet and dry, having been lately opened, 'were found to be decayed, and no longer serviceable.'"

The Suffolk and Essex methods of subsoil-draining, historically but briefly noticed in our section on "The Ancient and Modern Practices of Draining," aim solely and directly at the immediate formation of earthen or clayey conduits within the substance of the subsoil, and achieve, at the very outset, and without any of the risks and embarrassments of the drains from rotting materials, the same results which are slowly evolved in a long course of years from the most efficient and durable varieties of the method of filling up with billets and with other vegetable substances. Many varieties of these methods are in practice, differing little from one another in the manner of cutting the drains, but differing somewhat widely in the contrivances for leaving hollow ducts in the lower or terminational portions of each cut. A variety very common in Suffolk employs vegetable stuffings, and may be specially noticed as illustrating all the other varieties. A series of cuts is made, first with the plough, and next with hand implements, so as to form a graduated trench, terminating in a narrow central spit; and vegetable wisps or stuffings are applied, not within the spit but over it, of stubble, heath, straw, turf, hop-binds, or any similar substance, designed to serve as a roof to the duct of the spit, and as a floor to the earthy matters in the body of the trench. The application of the vegetable stuffings unfortunately bears the ambiguous designation of 'filling up;' but it really leaves all the duct or water-way perfectly open, and serves solely as a cover or ceiling to it, or as a support of the returned excavated earth, till an arch is formed. The drains are drawn slantingly across the slope of the ground, with a moderate fall; and, at their lowest points, are so met by connecting drains, that each group with its connecting drain carries off the water from an area of half an acre or three-quarters of an acre, and each connecting drain opens into the receiving ditch at a spot called the eye. In cutting the drains, first, a common plough goes two bouts to each drain, opening a furrow 18 inches wide and 5 inches deep; next, a large deep-breasted plough, kept for the purpose in some districts, goes once along this furrow, and turns out another furrow about 10 inches wide and 5 inches deep, so as to form a drain of 10 inches wide and 10 inches deep; next, a labourer, with a common spade, digs out, from the eye or bottom of this second furrow, a trench 9 inches deep, and as wide as the breadth of his spade; and next, the labourer, with a spade of 13 inches in mouth-length, and of a breadth diminishing from 2½ inches to 1½ inch, digs out, from the middle of the bottom of the trench, a spit of 11 inches in depth, and, with a peculiarly-formed and long-handled scoop, completely clears this spit of all crumbs or fragments of the excavated subsoil. The final depth thus attained is 30 inches. The vegetable stuffing is now so applied by pressure as to occupy the upper part of the spit to the depth of about 3 inches; and then the excavated earth, whether heavy or light, is shovelled in over the vegetable stuffing, and the common plough reverses its former work. The latter part of the excavating process is represented in *Fig.* 14, *Plate XXXVI.;* and the spade and the scoop employed in it are shown in *Fig.* 11.

One slight variation from the preceding method consists in laying a waggon-rope along the bottom of the spit during the process of the stuffing, and afterwards withdrawing it; but this is a mere precaution against the lodgment of crumbs of earth upon the bottom, and, if the scoop be properly used, is altogether unnecessary.—Another variety employs pieces of peat 15 inches long and 3 inches square, as a substitute for the vegetable stuffing, and gently presses them into the top of the spit to sustain and bear aloft the returned excavated earth; and these peats, we are told, "swell speedily, and become firmly fixed, and are very durable, and have this advantage over the other methods, and also over tile-draining, that a fold-stake driven into them commits no damage.—Another variety dispenses with all stuffing, places in the spit a board of such dimensions as exactly to fill it, turns down the earth upon the upper edge of the board so as to form a firm and compact mass over it, and then withdraws the board to the next part of the spit, there to repeat the operation.—Another variety has a sort of mongrel character, or rather belongs to the methods of actually filling up with vegetable substances; for it lays billets, faggot-wood, or thorns along the bottom of the cut, and places soft vegetable matter over it, leaving the water to find its way along the interstices between the pieces of wood; but this practice, though sometimes followed in the eastern counties, ought never to be quoted as a specimen of Suffolk or Essex draining.—A theoretic variety, proposed by Mr. Rham, employs tiles as roofing to the spits; and this, it is believed, would have a durability exceeding that of the best varieties by about ten years.

The drains of the Suffolk and Essex method of draining can be efficiently and durably made only in stiff clay lands; they are quite unsuited to light soils and subsoils, and, if made in them, will fall in; they possess little adaptation to even such stiff subsoils as have either a flakey or crumbling texture, or are intermixed with small water-worn stones; nor, though much prized for purely clayey lands, do they last longer, on even these, than from 12 to 20 years. Yet they are both so cheap and so efficient as to drain 300 acres for 20 years, while tile-drains of the same cost would drain 100 acres for 40 years; and when they begin to fail, they do not fall in throughout, but only become choked in spots, so that any field which is occupied with them can be again made dry by cutting a few new drains across the old ones. Though they figure somewhat poorly in description, and may be derided by some hot partisans of newer methods, they continue, after full investigation of the powers of tile-drains, stone-drains, and improved drains of other kinds, to be decidedly regarded, by some of the most distinguished agriculturists of England, as the most suitable for soils and subsoils of very tenacious clay. "Tiles and stone," says the Rev. Copinger Hill, "are disregarded by us, except for boggy soils, even since their use has been recalled to our notice by Scotch agriculturists; for our own system answers well, and is tested by time."—"This body of evidence," says Mr. Pusey respecting a mass of information and testimony on the Suffolk and Essex method, "sets at rest any question as to the English origin of thorough-drainage, showing that, for a century, it has been used generally in the large and well-farmed counties of Essex, Suffolk, and Norfolk, as well as in Hertfordshire. But it does more; it gives us the power of improving other English counties in a cheaper, and, I believe, a better manner than by the more modern processes of stone and tile draining used in the north,—I mean on heavy clay lands. It is incomparably cheaper than either, and I think better; because some of the evidence shows, and I have heard and seen, that tiles alone will *sometimes* not draw off the water upon our heavy English clays, and the stone in many such districts is not to be found."

A method of subsoil-draining somewhat akin in both nature and cheapness to the Suffolk and Essex method, but of much more extensive and varied adaptation, and specially suited to the very class of lands for which the other is unfit, has received the names of clay-draining, plug-draining, and wedge-draining. It is supposed to have been invented by a professional mole-drainer, as an improvement upon the common fragile method of making mole-drains; it was first tried on pasture-lands, and continues to be thought most suitable for them, but has also proved itself to be well suited to many kinds of ploughed land; and it began to come into practice about a quarter of a century ago, and has, in some parts of England, become greatly extended. The trenches are cut with the same kind of deep, narrow, terminal spit as those of the Suffolk and Essex method, but are both deeper and more capacious; a chain of blocks, plugs, or wedges, (represented in *Fig.* 10, *Plate XXXVI.*,) of exactly suitable dimensions, and so fixed to a chain as to be dragged forward by a lever, is placed in piece after piece of the spit; a mass of plastic, unctuous clay is spread, kneaded, trodden, and rammed over the top of the spit and of the upper edge of the chain of blocks, so as to form a firm and retentive arch after the chain of blocks is dragged away; and, finally, the excavated earth is returned into the trench, and, if the field be in grass, the pared-off sod is replaced on the surface. The operation must be performed, not only with wet clay, but while the land or subsoil itself is in a wet condition; and the drains require to have a fall of at least 1 in 60, and must be so arranged, as to distance and subdivision, that none shall sustain the risk of being gorged with water during a season of excessive rain. The ducts of these drains, of course, cannot receive water through the clay arch of their roof, but they freely and abundantly admit it through their sides and bottom; and though the portions of soil directly over them should, during the first season, be the wettest of the field, and even almost as wet as before the operation was performed, the drains may be seen, by inspection of their mouth, to be carrying away a profusion of water. Considerable nicety and care are requisite for the making of the drains in a sound manner; and no workmen should be employed on them but such as are skilful and trustworthy. One process of making them is clearly and minutely described, with accompanying diagrams, in the 3d vol. of the Royal Agricultural Society's Journal; and another process, somewhat different, and not with the same tools, is fully described in the 22d and 49th Nos. of the Quarterly Journal of Agriculture. The implement used in the latter for cutting the terminal spit, is the bitting or grafting iron represented in *Fig.* 13, *Plate XXXVI.* The width of the bottom at *a* is 1¾ in.;

the tongue or side-bit, *b*, worked out of the main-bit, has 6 inches of length of cut; the width of the back of the side-bit, *c*, is 4½ inches; the length of the main-bit, *d*, from the treading-step, *e*, to the bottom, is 18 inches; and the length of the handle, *f*, is about the same as that of a common spade. The turf 12 inches wide and 6½ inches deep is removed with the common spade; the second cut is made at such an angle down the side as to leave the bottom of the exact width of the tongue of the bitting-iron, at 9 inches in depth; and the third or completing cut is made with the bitting-iron 9 inches deep; so that the total cut is 12 inches wide at top, 24½ inches deep, and 1¾ inch wide at bottom. "The advantages of plug-draining," says one of the writers in the Quarterly Journal of Agriculture, "are so many and important, that it is quite surprising how little of it has been executed. Pasture land, which before had been deluged with surface water, has, in less than two years, undergone an entire change of character,—the aquatic grasses, with rushes, which, before draining, were its chief produce, having entirely disappeared, with various other weeds, whose chief support was derived from water, and their places have been supplied by several of the best and most nutritive grasses, with vast increase, both in bulk and quality."—A variety of the method of clay-draining dispenses with the uses of the chain of blocks or plugs in making the drains, and simply stuffs the top of the spits with clay in the same manner in which the Suffolk and Essex method does so with soft vegetable substances; and a writer in the Bath Papers states that, by the practice of this variety, he had so improved his farm as to feed off turnips with 800 sheep throughout winter on land which previously was so wet as to rot green crops.

A method of subsoil-draining, somewhat akin to clay-draining and to the Suffolk and Essex method, but decidedly inferior to both, has, for a considerable period, been practised in some of the clay districts of England, and is usually designated sod-draining. Several varieties of it are in use; but all are distinguished by the employment of sods or grass-turf coverings, roofs, or stuffings to the ducts of the drains. The cutting of the trenches for sod-draining, proceeds, in general, on the same principle, as that of the trenches for the Suffolk and the clay methods; yet it specially adapts the lower part of the excavation to the several varieties of manner in which the sods are applied. One variety of sod-draining scoops out a groove of 5 or 6 square inches in the bottom of the trench, leaves shoulders or ledges at the sides of the top of the groove, and lays the sods flat across the groove and the shoulders with the grassy side undermost. But in this variety, the sod rests the whole of its own weight and of the weight of the incumbent earth upon the shoulders of the trench, and is totally unsupported in the space over the groove; and it, in consequence, either promptly falls in from the effects of pressure or accident, or speedily gives way from the effects of its own decomposition and disintegration. Another variety digs the trench about a foot wide, doubles the sod into the shape of an inverted V, with the grass inwards, and so deposits the sod that it rests on its edges and has its bent middle upwards; and a third variety, nearly akin to this, cuts the lower part of the trench into a deep and narrow wedge-shape spit, and plugs or stuffs the top of this spit with pieces of sod in the form of truncated wedges. If the sod used in these two varieties have an arenaceous basis or an excess of vegetable matter, it will speedily fall in and stop up the ducts; but if it have a clayey basis and only a moderate proportion of grass, the ducts which it covers are likely to be of prolonged utility. But a fourth variety of sod-draining is both more common and more effective than the other varieties. The turf along the intended line of drain is cut into a four-angled shape, 9 inches wide at top, and 6 inches wide at bottom; and narrow wedges are cut off on each side, so as to leave the sod about 3 inches wide on the grass side, and 6 inches wide underneath. After the sod is removed, two successive spits of earth are taken out, of such dimensions and in such a manner, as to make a trench about 18 inches deep, 9 inches wide at top, and scarcely an inch wide at bottom; though both the depth and the width may vary to suit inequalities of surface. The sod is next placed in the trench with the grassy side downward; and, if carefully cut, it fits closely to the trench's sides, and will bear so great a weight that the more it is pressed from above, the firmer is its seat upon the sides. "Drains of this kind," says Mr. Brown of Heckington, "if carefully made, last many years. In the only case in which I have known well made sod drains require to be renewed, they had lasted about 20 years. In cutting ditches, sewers, &c., I have lately fallen in with sod drains considerably more than 20 years old, which were as sound as when they were first made. The expense of draining with sods is less than a third of the expense of draining with tiles. Supposing sod drains to last 20 years, the interest of the money saved by substituting sod-drains for tile-drains will more than pay the expense of renewing the sod-drains *ad infinitum*."

A method of under-draining strong clay lands, and especially meadow lands with a clay subsoil, in some counties of England, is effected with a draught implement called a mole-plough. A circular duct of about 2½ or 3 inches in diameter, is made by this implement at a given and uniform depth from the surface; and may be described as having the general form and character of either a clay pipe or a mole run. It is formed, not in the slightest degree by the extraction of earth, but wholly by compression; and the whole of it, except a slit along the top, is so firm and impervious as to resist the infiltration of water, and to act solely as a conduit-pipe. But the slit along its top is kept open either by the action of the weather upon the soil, or by means of the artificial insertion in it of a little plaited straw or some similar substance; so that the duct or drain dries the soil, entirely by receiving percolations of water through the slit, and therefore exerts a very limited range of power within the soil as to either depth or breadth. The implement has a beam, stilts, and coulter, in the form of a strong, rude, simple plough, and requires a draught-power somewhat greater than that of the common tillage plough. Its instrument of boring is a well-tempered, cast-iron, conically shaped share or bolt, of about 2½ or 3 inches in diameter at the hind end and sharp at the point; and this is attached to the beam of the plough and held fast by a very strong, flat, wrought-iron bar, sharp on the front edge and about an inch thick in the back, and capable of being lowered or heightened in position by means of bolts through its mortised attachment to the beam. The plough requires to be very evenly guided, so as to make a level or quite regularly sloping duct; and, on this account, it is sometimes constructed with wheels upon the fore part of its beam. An extraordinary variety of mole-plough draining has sometimes been practised in Essex; a furrow being first formed with a common plough, and then a duct being driven at the depth of from 14 to 18 inches, with a mole-plough drawn by 15 or 18 horses, three a-breast. Mole-plough draining of any kind is obviously impracticable in fields which have inequalities of surface; and it must, in even the most favourable circumstances, be regarded as of but very limited efficiency. The slit along the top of the duct which it makes in the soil, is cut partly by the coulter and partly by the bar which connects the share with the beam.

Flat-stone draining and slate draining have long been practised, in a considerable variety of ways, in districts which afford cheap and easy access to the quarrying of schistose rocks. In some places where the subsoil is deep, and of a loose and friable texture, square pipes of stone, called goughs, are formed at the bottom of the trenches, with a series of wide flat stones as a sole, with dry walls of splinters on the sides, and with a series of wide flat stones as a cover. The width of the duct, in these cases, is usually about 6 inches in the clear. In other places where the subsoil is similar and schistose stones are unattainable or scarce, goughs are constructed of bricks; and though expensive, are efficient and durable. When the bottom is firm, and the declivity is gentle, the series of sole-stones or sole-bricks is sometimes omitted.—In some instances, one series of slates or of flat stones is laid along the bottom of the drain as a sole, and two other series are placed slantingly on the sides so as to lean against each other at the top and form a triangular duct; but though these are frequently kept in their position by the lateral and perpendicular pressure of the small stones, the gravel, or the porous earth, with which the part of the trench immediately above them is filled up, they have a considerable liability to fall in and completely choke the ducts.—Another variety of flat-stone draining uses three series of stones, as in the preceding method, but in an inverted order, with the horizontal series, not as a sole, but as a cover; but this, though not in quite so great a degree, is also liable to the ruinous accident of falling in.—Another variety likewise uses three series of flat stones, but placed rectangularly, in the manner of base, perpendicular, and hypothenuse,—the base serving as the sole, and the perpendicular as one of the sides; but this variety is even more objectionable than the preceding.—Another variety places two or three or more slates or thin stones on edge, side by side, and lays over them a series of flat stones as a cover; but this is in the highest degree objectionable.—Flat stones can be set so as to give a free water-course in trenches cut as narrow at the bottom as for drain-tiles; for the workman may place himself in the trench in the same manner as when laying tiles, and may have the stones so laid alongside that he can reach them as required. One of several methods of forming flat stone ducts in narrow-bottomed trenches in strong clay land, is the following:—The trench is cut 5 inches wide at bottom; a series of stones, each 8 or 9 inches long, is placed with one end in one of the angles of the bottom, and with the other end resting on the opposite side, so as to leave a triangular duct below; another series of stones is so placed above as to form a second triangular duct, but on the opposite side of the trench; and a stratum of small stones or of sifted and gritty gravel is laid above the stones, and the upper part of the trench filled up in the same manner as in most other methods of draining.

Two varieties of mixed flat-stone drains have, within the last ten years, made a little claim on attention for their alleged combination of cheapness and efficiency,—the one a mongrel between flat-stone draining and the Suffolk subsoil-draining, and adapted to strong clay lands,—and the other a mongrel between flat-stone draining and assorted small-stone draining, and adapted to every kind of land. Preparation for either is made by so ploughing up ridged lea-land as to leave double furrows 16 inches wide at bottom, 32 inches wide at top, and 22 inches of depth at bottom below the level of the crown ridges; and the operation for forming the first is as follows:—Leave a ledge of one inch on each side of the bottom of the furrow left by the plough; cut out with the common spade a perpendicular trench 14 inches wide and 10 inches deep; cut out from the bottom, with a narrow-pointed spade, another trench of 5 inches in depth, and 4 inches in width, leaving a ledge of 5 inches on each side of the spade; place thin flat stones, greywacke flags, or stout coarse slates upon the 5 inch ledges so as to form a complete cover to the lower trench; and then fill up the upper trench and the furrow, in the usual manner, with the spade and the plough. The mongrel between the flat-stone drain and the assorted small stone drain is made as follows:—The spade takes out from the bottom of the deep and wide ploughed furrow a trench 16 inches deep, 8 inches wide at top, and 3 inches wide at bottom; two series of flags or flat stones are so placed against the sides of this trench that their lower edges rest against each other and form an acute angle at the bottom; a series of small hard stones is inserted between them, two-thirds down, so as to act like a wedge, and keep them asunder; the space above these wedge-stones, up to the top of the trench, is filled with riddled small stones, such as are used in the Deanston drains; and the rest of the work is done by an earthing over with spade and plough. Sections of drains formed according to these two methods are shown in *Fig.* 12, *Plate XXXVI.*

Rubble-draining is much esteemed in many districts where suitable materials for it can be obtained. It comprises numerous varieties, and is to a certain extent connected with tile-draining on the one hand, as with flat-stone draining on the other; yet it properly and generically consists in the packing of the lower part of a narrow trench either with assorted boulders not exceeding in size hen's eggs, or with small pieces of broken rock, similar to road-metal, and assorted to diameters of from 2½ to 4 inches. The operations for it admit of very numerous and somewhat wide diversities; and yet all have a general resemblance to the operations for both the flat-stone methods and the Suffolk and Essex methods. Mr. Smith of Deanston, who identifies with assorted small stone draining all his well-won celebrity as an experimental drainer, gives the following directions:—"The lines of drains having been marked off in the field, the drainer begins by cutting with a spade on a line, then removing a first spading of about 13 or 14 inches wide all along; another follows with a narrower and tapering spade made for the purpose, taking out another spading; and, when picking becomes necessary, a third man follows with a pick, and a fourth with a large scoop-shovel, to cast out the earth. A smaller scoop-shovel is used to clean out the bottom, which should be cut as narrow as will allow the last drainer a footing, generally about 3 or 4 inches. From 2 to 2½ feet from the surface are the best depths for such drains; the latter always to be preferred. The bottom should be cut as straight and uniform as possible, so that the water may flow freely along at all places; and it is better to cut a little deeper, where there is any sudden rise of the surface, than to follow it; and where sudden hollows occur, the cutting may, on the same principle, be less deep; attention to this also admits of after-straightening or levelling of the surface, without any injury to the drains. The workmen in cutting should throw the earth to the right and left from each alternate drain, as that allows the plough to go regularly and be constantly occupied in filling in the earth, whilst each alternate ridge or space is left for getting in the stones, free from the earth thrown out. The stones may either be laid down at intervals by the sides of the drains, to be there broken; or, being broken in masses at some convenient spot, and at such convenient seasons as best suit for the employment of spare labour, can be brought by the carts ready to be filled in. No stones should be filled in till the whole line of drain has been cut and inspected; but the sooner drains are completed after having been cut the better, and they should always be filled from the higher level downwards. Sometimes, when there is much tendency of the sides to fall in, it becomes necessary to fill in going along. Cutting in the summer, when there is little water in the soil, or in any dry season, saves much of this. In soft or sandy bottoms, by cutting the drains to half the depth in the first instance, and allowing them to remain so until the water has been voided from the upper stratum, the lower part may then be cut out with more safety from falling in."—Another distinguished drainer, Mr. Roberton, recommends drains 33 inches deep, 7 inches wide at bottom, and 9 inches wide at the height of the stones; another, Mr. Stirling, recommends drains 30 inches deep, 5 inches wide at the bottom, and 8 inches wide at 15 inches from the bottom or at the top of the stones; and another, Mr. Stephens, recommends drains of the width and gauge of the common spade;—and all these, as well as other eminent stone-drainers, advocate some peculiarities as to either the kind and size of the stones, or the manner of preparing them, or the process of filling them in. Boulders, however, when all as nearly as possible about the size of hen's eggs, clearly afford an easier, a more capacious, and a more durable water-way than broken or angular stones; and broken stones of the gauge-diameter of 2½ inches are obviously much more suitable for trenches of only 5 inches or so in width than stones of the gauge-diameter of 4 inches.

The usual practice, in making rubble-drains, is to cover the bed of stones with reversed green sods, or a layer of straw, dry leaves, dry brackens, coarse bog hay, tanner's refuse, or some other soft vegetable substance; and sometimes, as an additional precaution against earthy matter finding its way to the interstices among the stones, a stratum of two inches or so of adhesive soil or subsoil is trampled or beaten down upon the vegetable layer, to assist in the formation of a permanent crust. But the vegetable matter, whether in a layer by itself or as part of a sheet of sods, very soon decays, and, being lighter than the soil, is carried downward by any water which descends perpendicularly to the drain from the surface; so that the cover of vegetable matter is as certainly an eventual evil as it is a present good. Mr. Roberton, however, so breaks, graduates, and fills in the stones as to make a cover quite impermeable by soil, without any aid from vegetable matter. The principal implements for his process are a portable double screen or harp, a tail-board, a small iron rake, and a beater. The screen is represented in *Fig.* 15, *Plate XXXVI.* The main part of it is placed over a wheelbarrow, and has its bars at distances suited to the materials; its upper end is hung upon two posts about 3 feet above the barrow; a spout with a moveable board is attached to the lower end; and the second screen, or subordinate part of the double screen, is about half the length of the other, and hangs about 10 inches below it and parallel to it, and has its bars about half an inch apart from one another. The tail-board is a moveable trough, attached to the hinder part of the cart, to receive stray stones during the process of shovelling out. The small iron rake is employed to make the surface of the bed of larger stones in the trench level before the filling in of the smaller stones. And the beater is a square block of wood, of the width of the trench, and with an upright and cross-barred handle, to beat the smaller stones into the interstices of the surface layer of the larger ones, and thus make the final surface of the stones so level and firm as to be impermeable by soil. "When the screen is used, all the earth taken out to form the drains should be thrown to one side of the drain. The barrow is then placed on the other side, so as the board fixed to the lower end of the spout shall reach to the opposite side of the drain. The cart is placed upon the same side of the drain as the barrow, but a little in advance; the workman, having fixed the tail-board to the hind part of the cart, then shovels the stones over the upper end of the screen. The proper method is, to rest the shovel upon the upper part of the screen, which may be shod with plate-iron, and merely turn it over, by which a separation of the stone is at once made; the larger roll down, strike the board, and drop into the bottom of the drain, without disturbing the earth on either side; the smaller pass through the first screen, and being there separated from the rubbish by the second screen, fall into the barrow whilst the rubbish descends to the ground on the side of the barrow furthest from the drain. The one man takes charge of the filling of the drain; his duty is to move the barrow along the side of the drain, as this is filled with the larger stones to the required height; to level them with the rake; to shovel the smaller from the barrow, spread them regularly over the top of the larger, and beat them down with the beater, so as to form a close and level surface through which no earth can pass. The stones are so broken in the quarry, as to pass through a *ring four inches* in diameter; a great *proportion of them, however,* are much smaller, and when filled into the carts generally about one-fourth are so small, or, if not, should be made so small, as to pass through the bars of the upper screen, which are, for such materials, about 1¾ inch apart, and then they will be found sufficient to give to the top of the drain a covering of from two to three inches in depth, which, being beaten closely down, require neither straw, sod, nor any thing else to cover them."

Tile-draining has, in recent times, become the most extensive and conspicuous of all the methods of subsoil-draining. Most draining tiles have more or less of a semicylindrical form; but all good ones are a fourth greater in height than in width, and have their top rather rapidly curved, and their sides nearly perpendicular. Some tiles have a flattish top and somewhat spreading sides,—but these form a bad water-way, and are comparatively frangible; and others are made with flanges, or a kind of outspread feet,—but these are liable to sink irregularly in the soil, and to occasion both diminution and derangement of the water-way. All sound and durable tiles are firm, smooth, and comparatively heavy; they yield a sound like that of cast-iron to a stroke with the knuckles or with a piece of stick; and they are so strong that neither the pressure of a man's weight nor a smart kick with his foot will break them. The tiles in use, throughout the many clay districts of Britain, are exceedingly various in at once form, width, height, and length; and they also exhibit diversities in their mutual or relative sizes for main and subordinate drains, and in their means of adaptation to the junction of ducts at the rectangles, or joints of a system of drainage. But the varieties, the forms, the adaptations, the materials, the manufacture, and the prices of drain-tiles present so many questions of practical interest to farmers, that we reserve the discussion of them to a separate article under the word TILE.—Soles ought, in every case, to be laid for the tiles; and these also, when made of the same material as the tiles, vary somewhat in form, and very much in size and quality. But slates and hard stone-slabs, whenever they can be readily and cheaply obtained in schistose districts, make excellent soles. The use of soles on very firm clayey subsoil is pronounced by most agricultural writers superfluous; but, to all persons who reflect for even a few seconds on the deeply erosive power of running water, it will appear to be in all cases essential to the due or even moderate durability of tile-drains.

The processes of forming tile-drains are various; but the following, recommended by Mr. Carmichael of Raploch, in the highest of three Prize-Essays on the subject, published in the Transactions of the Highland Society, may be regarded as one of the best. The dimensions of the main-drain must be determined by the probable volume of the water to be drawn off; and this depends on both the extent and the quality of the ground. In a field of about 10 acres, perfectly free from springs, a main-drain, with a moderate fall, may consist of one tile, 8 inches by 10 in the clear, upon a soled and neatly and accurately adjusted bottom of about 12 inches. When two tiles are thought necessary, they are much stronger when placed upon two soles abreast upon a bottom of 24 inches in width, than when used without soles, and so inverted on each other as to form a tubular or cylindrical duct; and the soles ought to rest fairly and freely on the bottom of the trench, and to be adjusted as closely as possible to its sides. The mouth of the main-drain ought to be 12 inches or more higher than the bottom of the open ditch into which it flows, and should be finished with brick-work or masonry, and furnished with such a grating as shall exclude vermin. The trench being dug in the same way as for small-stone drains, the workman enters the lower end of it, lays soles and tiles alternately, presses each so close to the preceding as to leave no irregular joint, and thus proceeds, in an upward and backward direction, or with his face toward the part finished, till he arrive at the upper end of the drain. When the duct is double, the soles are placed either across the bottom or in pairs, and two tiles are placed abreast; when it is triple, the third tile, either with or without a sole, is placed over the first two; and when it is quadruple, the two lower tiles are placed invertedly upon a tight packing of tough turf, a pair of soles is laid above them, and the two other tiles are placed in proper position upon the soles. In sandy or very friable subsoil, the sides of the trench sometimes require to be cradled with wood during the process of laying the tiles; and when an open cast is required as a continuation of a covered drain, along very low ground to the sea or to a tidal river, the breadth of the cast, in order to give the requisite slope to the sides, ought to be equal to twice its depth. In forming the subordinate drains, the digger of the trench commences at the proposed junction with the main-drain, and works backward; and the layer of the tiles speedily follows him in the same direction, placing sole and tile in the same manner as in a one-duct main-drain, and using care as he proceeds to remove every portion of fallen earth which might either mar the evenness of the bottom, or find its way into the ducts.

A covering of very porous mineral, or of some kind of soft vegetable matter, is placed, by the great majority of drainers, immediately over the tiles, and is recommended by Mr. Carmichael to be abundantly supplied. Small stones, gravel, scoria, and the refuse of furnaces, are preferred whenever they can be economically obtained; masses of hypnums, sphagnums, and the allied cryptogams of peat moss are also thought very suitable; sods, with the grassy side downward, are regarded by some theorizing drainers, as the very best covering for either tiles or rubble; and straw, small brushwood, coarse bog hay, and similar substances are extensively employed as succedanea for more desirable but unattainable materials. "A covering of some kind or other," says Mr. Carmichael, "should not be scantily supplied, particularly in strong adhesive clay soil, where the compression caused by the continual treading of the teams in cultivated land, is most apt to bring the clay into closer contact with the tiles, and mar their utility. It was this consideration which suggested the idea of leaving holes in the tiles, or placing the drain a little to one side of the furrow; both of which plans have now become the less necessary where the above precautions are duly attended to, and no teams allowed to go along the furrows in harvesting the crops." A question, however, has of late years been much debated whether a porous covering of drain-tiles do not impede rather than promote the drainage; and this question has been firmly answered by several distinguished drainers, in favour of an immediate and entire filling up with the excavated earth, and even of a treading of it into a firm and compact condition; and though some of these say that a sod covering may, in various situations, be serviceable for excluding sand and granulous earth, others assert that a firmly trodden roofing of unctuous clay is the best protection against even this evil, and all deny that any facility whatever for the abduction of water is afforded by any sort of porous-covering whatever. "In no part of draining," says Mr. Beart, who may be viewed as a fair representative of this school of improvers, "is there greater ignorance shown than in filling-in the drain after the conduit is formed upon tenacious clay-soils. The modes adopted are very numerous, many of which I am unacquainted with, but the system generally adopted is to fill the drain immediately over the conduit with sod or turf, refuse wood, straw, or the surface-soil. The use of a good tough sod one inch thick, laid immediately over the tile to prevent the entry into the conduit of sand or other light substances with which the drain above the same is filled, is in many instances beneficial; but, with this exception, I am most decidedly opposed to putting any of the materials named in preference to the clay immediately above the conduit. I have shown that attention to levelling the surface and deep draining is the most effectual in laying land dry, and not the material used to fill in above the conduit; but if the difficulty did lie immediately over the conduit, and not at the surface, clay is a better material than mixed soil. Where drains are filled in with mixed soil, injury is likely to accrue to the conduit by the soil running down and choking it, and particularly so if the conduit is formed of wood or straw, when it decays. If the mixed soil does not run into the conduit, but concretes, it will be more impervious to the entry of water than clay, as mixed soils contract much less than clay from the action of the atmosphere and operation of under-drains. I have repeatedly observed in heavy rains, on land imperfectly drained, the water running to the lower end of the field, and overflowing the lands almost to the ridges; the greater quantity will percolate rapidly through the tilth and fissures to the conduit of the drain; but the smaller quantity, when it is reduced to the furrow, and has to filter through the deposit of mud and filling-in, will be days in disappearing, unless aided by drying winds or frost, which, by contracting the surface soil, admits the water into the fissures of the subsoil. With drying winds part of the water is evaporated, but by frost it is the contraction of the soil only which facilitates its infiltration, so that water will disappear in one night which would otherwise lie for days."

The uniting of rubble-draining and tile-draining into one combined method, seems to be very generally regarded as the master-piece of the art of subsoil-draining. A series of soles and tiles are laid in the same manner as in simple one-duct tile-draining, but always with soles considerably greater than the tiles; small stones are deposited by hand on both sides of the tile, till the latter is covered; a bed of small stones is next deposited by means of the drain-screen or of a shovel, upon the top; and the whole is then covered, filled, and finished in the same manner as in simple rubble drains. The duct of the tile thus laid is the smoothest possible conduit for water, and is inaccessible by vermin; packing of small stones immediately round the tile, holds the latter firmly in its place, prevents accidents, and secures durability; the superincumbent bed of small stones presents a large area for lateral infiltration from the subsoil, cuts off all injurious communication by pressure from above with the tile, and serves, in emergencies of excessive fall of water, as an additional duct; and, at the same time, the covering and filling-in of the whole may be performed either on the principles of infiltration from above, or on what appear to us the far more enlightened principles of infiltration solely from the sides. This combination of rubble-draining with tile-draining is, of course, impracticable in districts where suitable stones do not exist, and involves considerable additional expense in districts where suitable stones are abundant; and it will, in any case, commend itself to prudent adoption only when the extra advantages of it appear to be a full counterpoise to its extra costs.

Draining by means of concrete or mortar tiles is a recent invention of Lord James Hay, and is designed as a cheap substitute for clay-tile draining. The concrete intimately resembles building mortar; it consists of hot lime, sharp sand, and small gravel, in proportions suited to the strength of the lime; and when made from the strongest kinds of lime, it is of the best quality, and hardens soonest under water, or in damp situations, or when used for the purposes of draining. If lime contain 74 per cent. of carbonate, one part of it requires to be mixed with 1½ part of sand and 3 parts of gravel; and if the lime be ground, and the sand and gravel added to it before the water, the concrete will be harder than if made in the manner of ordinary mortar. But if lime contain 90 per cent. of carbonate, one part of it requires to be mixed with 7 parts of sand and gravel; and a bushel of it prepared with these admixtures will make 160 tiles, each one foot in length. The tiles are wrought on moulds by means of cast-metal trowels; and if made on the open ground, they will soon harden by exposure to the weather, and may eventually be used in the same manner as common clay tiles. But the concrete can be carted to the field, and made into soles and tiles on the bottom of trenches, so as to economize labour and expense, and to render the tile-making and the drain-making a simultaneous and conjoint process. The sole of the drain is formed of the concrete, about an inch thick, or rather more; and then the drain tile is formed over the mould,—the bottom of which is so curved as to facilitate its being withdrawn, and at the same time to make a groove in the sole for the more ready flow of the water. A wire is placed transversely under the sole, at the distance of every foot; and when the mould is drawn forward in the trench, the wire is pulled vertically up, so as to cut the sole and the drain at every foot, and to make a slit all round them for the ingress of water; or a mason's trowel may, in lieu of the wire, be so thrust through the tile and the sole at every foot as to make the requisite series of openings. In clay lands, some clay may be placed over the tile before the withdrawal of the mould, in order to protect the concrete till the latter harden; or a wedge of clay may be placed for mechanical protection, and the whole of the excavated earth be immediately returned into the trench. In pasture lands and grass fields, a sod may, with its grassy side downward, be laid upon the concrete, and the trench be immediately filled. The concrete, when formed in the trench, should contain as little moisture as will comport with free plasticity; and it will then offer a much firmer resistance to pressure from above, than if it were moist and soft. It acquires greatly increased compactness and mechanical strength from exposure to the air during a few hours in the trench, so that whenever its capability of resisting pressure is doubtful, it ought to enjoy such exposure previous to the filling-in of the excavated earth; and, in extreme cases, it may, without injury to itself and with little increase of labour in the operation, be allowed to continue exposed during several days.

Pipe-tile draining has, within the last 4 or 5 years, come into extensive use in several great districts of England, and is strenuously advocated by some of the most distinguished English agriculturists. Its ducts are pipes of small diameter, and of the same materials as common clay tiles;

they act simply by receiving the water at their joints, and carrying it off along their bore; they require no niceties as to either trenching or covering; they seem well adapted to systems of very deep drainage, and are becoming, in a great degree, identified with them; and they recommend themselves to adoption by at once their simplicity, their cheapness, and their durability. The first tile-pipes used for draining were made about thirty-eight years ago at Horsemonden in Kent, by bending shots of tile clay over wooden cylindrical mandrils; and they were about 3 inches in interior diameter, and had a narrow slit from end to end, occasioned by the imperfect junction of the two edges of the sheets of clay, and supposed, though quite erroneously, to be requisite for affording infiltration to the water; but these pipes never came into extensive use, and do not seem to have ever become known beyond a very limited locality. Tile-pipes, without any slit, and of a perfectly cylindrical form, began, at a considerably later period, to be made in Essex, and were thence adopted into Suffolk and Sussex; yet even these were for a time unknown beyond the limits of the districts in which they were made, and eventually became known to the rest of England conjointly with the old methods of Essex and Suffolk subsoil-draining. In 1843, pipe-tiles were made of various interior diameters from 1 inch to 2¼ inches, and were constructed by means of a very simple machine which cost about £6 or £7; and up to that date, about a million of feet of them were supposed to have been produced by ten little establishments in nine parishes of Kent. But, at the Royal Agricultural Society's meeting at Newcastle-on-Tyne in July, 1846, Mr. Parkes, the consulting engineer of the Society, said, "There existed, in 1843, only a machine of a rude kind for manufacturing drain pipes; but through the wide-spread information conveyed by the pages of the Society's Journals, and the prizes offered by it for superior machines, we have arrived, in the short space of three years, to that agreeable dilemma which actually renders the selections in our show-yard of the most meritorious pipe-machine a matter of no little difficulty. From a machine having the faculty of producing about 1,000 feet of pipes per diem, we have advanced, in less than three years, to the faculty of making 20,000 feet in the same time; in truth, the power of production by many of these machines, is considerably though usefully greater than the requirements of any tilery."

So great efficiency is ascribed to tile-pipe drains by their partisans, that Mr. Parkes considers the fortuitious discovery of their use a powerful corroboration of a principle at which he and other distinguished English agriculturists had been arriving,—that an increase of depth in the position of the draining duct, down to at least four feet from the surface, is attended by a corresponding increase in the lateral range of the draining power. An instance reported in the Royal Agricultural Society's Journal of 1843, may be quoted as a fair illustration of both the efficiency of the tile-pipes and the manner in which they are used. Mr. Taylor of Brewer's Hall in Kent, after stating that he had tried the original or slitten kind of pipes, and been perfectly satisfied with them, says, "There is now another sort of pipe-tiles made by machine, having no opening in their length, only at the joints, and much thinner, which are used to greater advantage. I have used them in drains over 40 rods long, and never saw one pipe more than two-thirds full of water. Within half an hour after heavy rain commences, these drains run fast, and in a few hours after its cessation they run but slowly; consequently a large and expensive tile is useless where a much smaller and cheaper one will do the same work. I have my drains dug from 3 feet 6 inches to 4 feet deep; the bottom of the drain is left for the pipe to quite fill it, so that it is impossible for the pipe to move after it is put into the drain. Clay is then well-rammed over the pipes to 2 feet in depth, which I prefer to anything else when it can be got to cover the tile. I have also used these pipes on boggy soils which would produce neither grass nor corn; they now give good crops of both. These drains run throughout the whole summer."

A tile duct invented by Mr. Etheridge of Woodlands near Southampton, and usually called after his name, possesses an intermediate character between the common tile and the tile-pipe, and has, during the last three or four years, competed with both for public favour. It resembles the common tile in consisting of two parts, and the tile-pipe in smallness of bore and slenderness of proportions; but it differs from the former in having a lid instead of a sole, and from the latter in being usually double or treble its weight. It is made of various dimensions; and its bore may either be cylindrical, semi-cycloidal, oval, horse-shoe-form, angular, or flattened. Some experimentalists have pronounced it more effective, and all have found it considerably cheaper, than the common tile duct. But a joint view of some of the best kinds of Etheridge tile, of some of the best kinds of pipe-tile, and of the Tweddale or confessedly best variety of the common tile, as these were manufactured in the south of England in 1843, will afford valuable aid in estimating their comparative merits. Tweeddale tiles of 2¾ inches internal diameter, 6¾ inches area, 14¼ inches length, and 0·55 inch thickness, together with their soles, weighed 5,500 lbs. per thousand, or 4,631 lbs. per 1,000 feet, yielded 484 lineal feet per ton, and cost £2 2s. per thousand, or £1 15s. 4d. per 1,000 feet; Etheridge tiles of 2½ by 1½ inches internal diameter, 3·18 inches area, 14¼ inches length, and 0·65 inch thickness, together with their lids, weighed 5,600 lbs. per thousand, or 4,717 lbs. per 1,000 feet, yielded 475 lineal feet per ton, and cost £1 10s. per thousand or £1 5s. 3d. per 1,000 feet; Etheridge tiles of 1⅓ by 1½ inch internal diameter, 1·56 inch area, 14½ inches length, and 0·65 inch thickness, together with their lids, weighed 5,152 lbs. per thousand, or 4,338 lbs. per 1,000 feet, yielded 539 lineal feet per ton, and cost the same price as the preceding; tile pipes of 2¼ inches internal diameter, 3·97 inches area, 12 inches length, and 0·40 inch thickness, weighed 2,844 lbs. per 1,000, yielded 787 lineal feet per ton, and cost £1 18s. per 1,000; pipe tiles of 2 inches internal diameter, 3·14 inches area, 12 inches length, and 0·40 inch thickness, weighed 2,657 lbs. per 1,000, yielded 843 lineal feet per ton, and cost £1 14s. per 1,000; tile pipes of 1·6 inch internal diameter, 2·01 inch area, 12 inches length, and 0·35 inch thickness, weighed 1,937 lbs. per 1,000, yielded 1,156 lineal feet per ton, and cost £1 9s. per 1,000; tile pipes of 1·35 inch internal diameter, 1·43 inch area, 12 inches length, and 0·35 inch thickness, weighed 1,313 lbs. per 1,000, yielded 1,706 lineal feet per ton, and cost £1 5s. per 1,000; and pipe tiles of 1 inch internal diameter, 0·79 inch area, 12 inches length, and 0·25 inch thickness, weighed 1,032 lbs. per 1,000, yielded 2,170 lineal feet per ton, and cost £1 1s. per 1,000.

The forming of drain-trenches by means of specially constructed ploughs has long been an object of general desire, and repeatedly an object of strenuous and ingenious attempt. The ploughing out of small surface drains on grass lands, and the ploughing out of the upper part of subsoil trenches, to prepare them for the subsequent operations of the draining spade, are easy achievements, and ought to be generally practised; but the ploughing out of the whole depth of subsoil trenches, especially if that depth must be kept at a minimum of 27 or 30 inches, appears, except in very special instances, or without a wasteful amount of cost, to be altogether unattainable. Several draining ploughs which promised well, and won premiums for their inventors, were soon found to be sadly deficient and were thrown aside; and even two or three which excel and survive the rest are efficient only in a special kind of land, and with the use of an enormous amount of horse-draught. The draining-plough of Mr. MacEwan of Blackdub in Stirlingshire, smoothly cuts its way through fine unctuous clay, and somewhat regularly lays aside the large tenacious furrow-slice; but it requires for even this land to be drawn by 6 pairs of horses, and is utterly impracticable in subsoils which contain any mixture of gravel or boulders, or which are not quite fine and homogeneous in their earthy constituents. The draining-plough of Mr. Pearson of Frotterden in Kent, cuts out a trench of 26 inches in depth, and is somewhat adapted to preparation for clay-draining or plug-draining; but it requires both to be drawn by great horse-power, and followed by the use of the hand-scoop. The draining-plough of Mr. Robert Green of Cambridgeshire, makes three successive cuts for every drain, and eventually forms a trench 23 inches deep, 8 inches wide at top, and 2 inches wide at bottom; and it can achieve its object only in stiff, fine, and homogeneous clay. The draining-ploughs of Mr. Alexander of Taylorton, in Stirlingshire, are two in number, a leader and a follower, and perform their work on the principle of cutting the trench on both sides with coulters, and gradually elevating the cut and loosened earth upon the inclined plain of the mould-board, till it is thrown off and deposited at the side on the surface; the leader takes out a depth of 16 or 18 inches, with a width of 17 inches at top and 7 inches at bottom, and the follower takes out an additional depth of 8 or 10 inches, with a terminating width of 5 inches, and without making any change in the width of the surface; they require, for their proper work, to be drawn by 10 horses, and are capable of being alternately transmuted into subsoil-ploughs and draining-ploughs; and the cost of cutting drain-trenches with them is estimated by their inventor, in his premium report upon them in the Transactions of the Highland Society, at a trifle more than one-half of the cost of forming the trenches with the spade. But even these ploughs are not at all likely to come into general use.

The depth and the frequency of subsoil-drains are in a great degree dependent on each other, and have been subjects of much misapprehension and considerable controversy. The proper depth of drains in cold clay lands, in particular, provokes more debate and is the topic of wider differences of opinion than any other great practical agricultural question of the present day. Yet most of the differences of opinion arise from the blinding influence of immediate pecuniary advantage; and nearly all the remainder may be ascribed to ignorance, prejudice, and fondness for theory. Though proper depth of drains must, in some degree, vary according to differences in the character of land, yet it cannot, in any instance, be less than to draw water away from the utmost possible range of the roots of plants, and to afford free scope for the operations of the subsoil-plough. By descending only 3 or 4 inches less than what is proper, drains may dry merely the surface portions of the soil, and confer no advantage whatever upon the aggregate character of the land. Or as the late Mr. Stephens long ago remarked, "Land may be filled full of small drains, so that the surface shall appear to be dry, but the land thus attempted to be drained will never produce a crop, either in quality or quantity, equal to land that has been perfectly drained." The old system of placing the drains on the mere bed of the soil, or in the highest stratum of the subsoil, served scarcely any purpose except to deceive farmers and rob them of a portion of their money. Even modern systems have been very generally controlled and limited by the mere exigencies of culture and implements, and by a narrow-sighted and mischievous though quite natural desire to restrict expense whenever the materials used were dear and the cost of forming and filling the trenches great. The errors hitherto committed, have, with probably not a single exception, been all on the side of shallowness and apparent parsimony; for multitudes of farmers have been obliged to drain their fields a second time and at a greater depth, while not one that we know of, has taken up deep-laid drains and placed them nearer the surface. Both as materials have become cheaper, or as cheap methods have superseded dear ones, and as the mechanical and chemical principles by which draining operates upon the land have come to be better understood, the propriety of increasing both the depth and the distances of drains has been more and more recognised. The perspicacious and spirited achievements of Mr. Smith of Deanston, were speedily followed by a conviction among all classes of well-informed agriculturists, that the proper depth of drains in even the most favourable clay lands cannot be less than 27 or perhaps 30 inches; and the more recent researches and experiments of Mr. Parkes, Mr. Pusey, Mr. Arkell, and other distinguished English improvers, respecting the action of clay-drains and tile-pipes, appear to be rapidly producing a general conviction that the minimum proper depth is 3½ or even 4 feet.

An instance of the comparative depth of drains mentioned by Mr. Parkes, together with his masterly reasoning upon it, is so enlightening on this contested subject, that we should be unjust to our readers if we did not quote it. "I will now mention an experiment which every farmer is competent to make, and which cannot fail to throw light on the action and effect of his drains, and on the relative condition of different pieces of land as to porosity, or filtrating activity,—I allude to the simple ascertainment, by measure, of the quantity of water discharged from different drains, after rain, in the same time. In reply to numerous inquiries on this subject, I have only succeeded in obtaining sufficiently exact information from Mr. Hammond, whose intelligence had led him to make the experiment without any suggestion from me. He states—'I found after the late rains (Feb. 17, 1844,) that a drain 4 feet deep, ran 8 pints of water in the same time that another 3 feet deep ran 5 pints, although placed at equal distances.' The circumstances under which this experiment was made, as well as its indications, deserve particular notice. The site was a hop-ground, which had been under-drained 35 years since to a depth varying from 24 to 30 inches; and though the drains were laid somewhat irregularly and imperfectly, they had been maintained in good action. Mr. Hammond, however, suspecting injury to be still done to the plants and the soil by bottom water, which he knew to stagnate below the old drains, again under-drained the piece in 1842 with inch pipes, in part to 3 feet, and in part to 4 feet in depth, the effect proving very beneficial. The old drains were left undisturbed, but thenceforth ceased running, the whole of the water passing below them to the new drains, as was to be expected. The distance between the new drains is 26 feet, their length 150 yards, the fall identical, the soil clay. The experiment was made on two drains adjoining each other, that is on the last of the series of the 3 feet, and the first of the series of the 4 feet drains. The sum of the flow from these two drains at the time of the trial, was 975 lbs. per hour, or at the rate of 19½ tons per acre in 24 hours—the proportionate discharge therefore was 12 tons by the 4 feet, and 7½ tons by the 3 feet drain. No springs affected the results. Hence we have two phenomena very satisfactorily disclosed; first, that the deepest drain received the most water; second, that it discharged the greatest quantity of water in a given time—the superficial area of supply being the same to both drains. It would appear, then, either that the deeper drain had the power of drawing water from a horizontal distance greater by the ratio of 8 to 5 than the shallower drain; or that the perpendicular descent of the water was more rapid into the 4 feet drain; or that its increased discharge was owing to both these causes combined. The phenomenon of a deep drain drawing water out of the soil from a greater distance than a shallower one, is consistent with the laws of hydraulics, and is corroborated by numberless observations on the action of wells, &c.; but the cause of the deeper drain receiving more water *in a given time* is not so obvious. An opposite result, as to time, would rather be expected from the fact of water falling on the surface having to permeate a greater mass of earth both perpendicularly and horizontally, in order to reach the deep drain. A natural agricultural bed of porous soil resembles an artificial filter, and it is unquestionable that the greater the depth of matter composing such filter, the slower is the passage of water through it. In stiff loams and clays, however, but more particularly as regards the latter earth, the resemblance ceases, as these soils can permit free ingress and egress to rain-water, only after the establishment of that thorough net-work of cracks or fissures, which is occasioned in them by the shrinkage of the mass from the joint action of drains and superficial evaporation. These fissures seem to stand in the stead of porosity in such soils, and serve to conduct water to drains rapidly after it has trickled through the worked bed; it is possible, too, that in deeply drained clays of certain texture the fissures may be wider, or more numerous, in consequence of the contraction of a greater bulk of earth than when such soil is drained to a less depth. However this may be, it is asserted by some respectable and intelligent farmers in Kent, who have laid drains very deeply in clays and stiff soils, that the flow from the deepest drains invariably commences and ceases sooner than from shallower drains, after rain."

Other instances, bearing on the same great question, are detailed by Mr. Parkes in the Journal of the Royal Agricultural Society; many were accumulated by him previous to that Society's meeting at Newcastle in 1846,—so as to have induced him to say, on that occasion, "The evidence to my mind is irresistible that a less depth of drain than 4 feet in any soil will not be accompanied by those beneficial results which we obtain at that, and in some soils by a still greater depth;" and multitudes have, for two or three years past, begun to present themselves to observation and inquiry in the best-farmed clay districts of England, particularly in Kent. Draining at the depth of 3½ and 4 feet, in fact, has come to be almost the prevailing practice in the choicest of the pipe-tile districts; and has no doubt been greatly encouraged by the cheapness, lightness, and approved action of the pipe-tiles, by the facility of laying them, and by the comparatively small cost of cutting the small trenches for their reception. Experimentalists have not been slow to try drains at the depth of 6 feet, and have found them to answer their anticipations; and, in a rare instance or two, they have—more for the sake of testing the principle of deep-draining than with any other view—tried them at even the quixotic depth of 10 feet. A very serious practical objection to deep draining upon either the rubble-stone method, or the common tile method, or almost any one of the older methods, is its great extra expense over 2½ feet draining; but this does not, in the slightest degree, affect the pipe-tile method, and probably admits of modification in reference to some of the other methods. The theoretic objections are, that the years of experiment in four-feet draining were peculiarly favourable to the fissuring of clay soil,—that four-feet drains, deposited in deep clay land in a state of thorough saturation and compactness, would be long in succeeding, and perhaps would never succeed, in so fissuring the land as to keep it open,—and that, after a long period of unusually continuous and heavy rains, tile-pipes, at a depth of four feet, might cease to have power to maintain the fissures, and so permit the land to become re-saturated and re-compact. Some readers may possibly attach to these objections sufficient importance to draw from them a lesson of caution; but most, we suspect, will regard them as wildly imaginary.

One limit to deep draining is either rockiness or thorough porosity of substrata; another is the impossibility or difficulty of obtaining a proper outlet for the water without deep and extensive cutting or some other operose and costly provision; and a third—though merely of a prudential nature—is the well-tried and thoroughly proven efficiency of shallower draining upon land of strictly homogeneous character.—The frequency of drains is so far dependent on the depth, that it cannot be settled till the latter is determined; and yet the mutual relation of the two is very far from being reducible to one fixed rule. In porous subsoils, drains draw from a far wider area than in clayey subsoils, and they may therefore be placed at correspondingly greater intervals from one another; and even in clayey subsoils, they considerably vary in the breadth of area from which they draw, yet act very nearly in the proportion of the homogeneousness or of the gravelly mixture of the clay. A three-feet drain, in the very stiffest clay land, draws from 6 or 7 feet on each side of it; in a partially impervious subsoil, 8 or 9 feet on each side; in a subsoil mediately pervious and impervious, 12 or 13 feet on each side; and in very favourable varieties of subsoil, from 15 to 33 feet on each side; so that the doubles of these distances are, in the respective cases the proper intervals between the drains. But, in every instance, the rule, so abundantly verified by the experiments in pipe-tile draining, may be regarded as applicable, that when the drains are made shallower, they require to be closer, and when made deeper, they may be at remoter distances.

The direction in which drains ought to run, whether in that of the inclination of the ground, or obliquely to that inclination, or quite across it, has also been a question of much controversy, but may now be regarded as so far settled, as to be almost beyond dispute. The late Mr. Stephens maintained that, "when the ground has the least declivity, the drains should always be directed obliquely across the slope, or as directly across it as the nature of the surface and outlet will allow," and that "drains winding across the slope or declivity of a field, whatever their number or depth may be, will have a much greater effect upon tenacious or impervious substrata than if they were made up and down the slope." But these views, though long adopted by most practical writers on draining, arose from a confounding of the principles of subsoil-draining with those of strata-draining, and have been abundantly proved, both by experiment and by joint appeal to hydraulics and geology, to be utterly erroneous. In rare cases of well-marked, regular, horizontal stratification, indeed, the placing of the drains across the slope, in the lines at which the bottoms or conveying levels of the strata crop out, will necessarily draw far more water, and effect both a more economical and a more powerful drainage, than the placing of them in the direction of the slope; yet when the strata are of irregular thickness, or do not present within the range of artificial drainage a series of conveying levels, the placing of the drains across the slope of even heterogeneously stratified subsoils may fail to draw water from below, and serve only the useless purpose of collecting it after it has oozed into the soil. Mr. Thomson of Hangingside in Linlithgowshire, narrates, in his Prize Essay in the Transactions of the Highland Society, instances of drainage in particular fields in which the direction across the slope completely failed, while the direction down the slope proved efficient; and after stating that the fields, upon examination, were found to consist of strata lying, not conformably with the surface slope, but horizontally, he concludes, "It is therefore obvious that, in making drains across a sloping surface, unless they are put in at the precise point where the substrata crop out, they may in a great measure prove nugatory, because, although one drain is near another, from the rise of the ground, none of them may reach the point sought." Mr. Young of Lesmahagow, in another Prize Essay in the Transactions of the Highland Society, appeals both to experiments and to the laws of hydraulics, and brings elaborately out the five conclusions,—that the cross-slope system has been seen to fail, but never the other, at least not to the same extent, —that when the two systems have been tried in the same field, the down-slope system has proved the more efficient,—that some apparently homogeneous soils are so pervious to water as to be quite undrainable by the cross-slope system, —that most diluvial strata are quite undrainable by the cross-slope system,—and that when drains upon either system duly act, those upon the down-slope system remain longer effective. All these conclusions, and those of other experimentalists, as well as the general results of draining experience during the last few years, are so many confirmations of the doctrine which was so perspicaciously propounded to the agricultural world by Mr. Smith of Deanston in his Remarks on Thorough-Draining:—"Drains drawn across a steep, cut the strata or layers of subsoil transversely; and as the stratification generally lies in sheets at an angle to the surface, the water passing in or between the strata, immediately below the bottom of one drain, nearly comes to the surface before reaching the next lower drain. But as water seeks the lowest level in all directions, if the strata be cut longitudinally by a drain directed down the steeps, the bottom of which cuts each stratum to the same distance from the surface, the water will flow into the drain at the intersecting point of each sheet or layer, on a level with the bottom of the drain, leaving one uniform depth of dry soil."

Deep, compact, homogeneous clay land possesses no perceptible strata, and suffers the percolation of water only through the cracks and fissures which are made in it by the joint action of droughts and artificial draining; and it might, therefore, seem to be capable of drainage quite as freely in cross or oblique directions as in the direction of the slope. Such, however, is not the case. A drain down the slope of a very declivitous piece of clay land receives the minute rills of drainage from both sides at comparatively acute angles; a drain down the slope of an inclined but not declivitous piece receives them at much less acute angles; a drain down the inclination of an apparently flat or almost level piece receives them at angles so slightly acute as to be within a degree or two of right angles; and all draw them off in their own direction, or with the angles of their junction pointing down the slope. Drains down the slope, therefore, even on the flattest clay lands, but with increasing ratio on inclined declivitous clay lands, are precisely in the direction to effect the greatest amount of drainage; while drains across the slope would simply be so many intercepting trenches, to dissever the channels of the draining rills into unconnected pieces, and to cut off upper sections of the ground from continuous drainage with the lower. "Let any one," says Mr. Arkell, in his Prize Essay, in the Journal of the Royal Agricultural Society—"Let any one go to a very wet piece of clay land on a steep descent, and cut a drain the necessary depth up the greatest fall, then cut another out of that across the piece nearly on a level, just as the water will run off into the other, then notice how the water enters each of them, and which will dry the most land; you will see in the former the water will enter equally on each side, and at the bottom; in the latter, it will come in only on the upper side, and that from the top to the bottom of the drain, forced in so by the weight of water above; therefore you find the land drained on each side of one, but only on one side of the other, the lower side namely, as there will be none dry above. Now, from the water entering the drain in such a manner, all upon one side, it may be necessary to fill the drains with something porous, as, if they were filled with tenacious soil, it would very likely conduct the water across the drain, and the drains be of little service, as they do not draw the water from the dried land below, but allow the land to dry itself from cutting the water off above it. If they act thus on steep land, it must be so in a measure on land that is flatter." The cross-slope draining of declivitous clay land, indeed, is far from being impracticable; but, in order to be as effective as down-slope draining, it requires the use, in even the most favourable cases, of a closer arrangement or considerably greater number of drains.

The durability of drains is dependent partly on the comparative excellence or faultiness of their formation, partly on the kind of materials employed, and partly on the care used to prevent accidents, to repair damages, and to maintain a state of integrity and vigorous action.—Proper digging of the trenches, proper laying or forming of the ducts, careful and regular adjustment of declination, the proper filling up of the trenches, and the avoiding of the proximity of the roots of growing trees or live fences, are essential precautions in the forming of the drains; and whenever the regular adjustment of declination is not guided by a very decided slope in the land, and by a trickling flow of water in the trench, it must be effected with the aid of the spirit-level, and conducted on a gradient of from 1 in 60 to 1 in 100. The durability of drains of wood and other vegetable matters varies chiefly according to the precise nature of the substance employed, and partly according to the peculiar chemical action of the land; and that of the principal kinds has been mentioned in the paragraphs descriptive of their respective character and formation. The durability of clay drains ought to be all but permanent, from the fact of there being nothing to destroy; and that of rubble drains and of good tile or tile-pipe drains, ought also to be all but permanent, in consequence of the almost indestructible nature of the materials. But even the best-made drains, of the best materials, require due care for their conservation. Accidents from fracture or depression, whether inflicted by the feet of cattle or in any other way, ought to be speedily repaired; deposits of earthy matter in the drains, whether by the sinking down of soil or by the boring of the fibrous roots of plants, ought to be speedily ascertained and removed; perforations or suction-holes direct from the surface of the land to any drain, ought to be promptly and firmly filled up; hard and rapidly-formed ferruginous deposits, from the solidification of iron held in a state of light flocculent mixture with the wet subsoil, ought to be combated by the use of the smallest kind of tile-pipes: and the fracture, derangement, or choking up of drains by the roots of trees, shrubs, and rank herbaceous weeds, ought—if not averted by prudence in the circumstances of forming the drains—to be, as far as possible remedied, by the removal of the obstructions, and the extirpation of the plants.

"One cause of obstruction to drains," said Mr. Parkes in his Lecture at Newcastle in 1846, "is the entrance into them of the roots of trees and plants. Of the former, several cases have been reported to me as having occurred, and probably no species of close under-drain, yet constructed, can be considered to be absolutely safe from the roots, if laid within the range of their travels; and the great distance from the parent tree, to which roots will travel in search of food, is well known to every agriculturist. It would be venturing too much to say that a root will not enter drains by any, even the smallest conceivable crevice or pore, which will admit water; for cases have been mentioned to me almost justifying the belief that roots have insinuated themselves through Roman cement. They seem, however, to be very capricious and choice in their attacks, for I have seen drains which have continued perfectly free in their action for years, adjoining fences and plantations, whilst a drain, at a greater distance, has been choked by roots. In the two or three cases observed by myself, I have found that a single thread-like root alone has entered, and then worked its way up against the run of the water, increasing into a hairy mass, something like the brush of a fox, and growing in length sometimes to several yards, until it closes the drain as completely as if it were stopped full of clay. I have repaired a drain 6 feet deep, thus stopped in a small plantation at Drayton Manor, by the root of a young chestnut-tree, by using 2 inch pipes 2 feet long, and collaring with pipes 6 inches long with cement; but this serves only as a conduit, and is not intended to act as a drain. I have also laid drains on each side of a road, having a row of trees within a very few yards of them, with sheathed pipes, not cemented, as they are wanted as drains. In situations where close drains must be laid near to trees, I would advise the keeping as far off as circumstances permit, and the providing each row of pipes, if joining a main, with a cess-pool at their junction, in order that the discharge may be visible and examined occasionally, which would soon detect a stoppage if it occurred. But it will be wise in all cases, if people will have hedge-row trees, that the drainer so plan his operations as to keep as wide of them and fences as possible—but, better still, to get trees felled wherever they occasion a feeling of doubt as to their affecting the permanency of the drainage, or cause it in respect of the direction or depth of the drains to be other than complete. If trees, as in parks, are in the way of drains, I advise the sheathing of the pipes on approaching within twenty yards; and I frequently diverge from the line and pass round the tree, to regain the true line of drainage.—With stoppages from the roots of plants I have only very recently become acquainted, but this evil does occur, though fortunately it is of very rare occurrence. The first case known to me took place this year in a field on an estate of Mr. W. Wolryche Whitmore, at Lebotwood, in Shropshire. A tenant of his laid a pipe-drain last March in a boggy piece of ground very wet and spongy, which was sown with turnips. The drains were found in many places to be completely stopped with very fine roots in October. It seems to be difficult, indeed impossible, to pronounce from what plant these roots proceeded. I sent specimens of them to Professors Lindley and Danberry, who kindly examined them, but neither of these botanists is able to decide on the parent plant, to which the roots unfortunately were not traced when the pipes were taken up. The drains were shallow, not exceeding two feet six inches deep anywhere. The boggy soil contained many sorts of weeds, as crowfoot, coltsfoot, rushes, and docks, of which there was abundant evidence when I was on the spot some weeks afterwards. The pipes sent me contained much earth, which had got into them, with the roots; and I understand that several of the pipes were almost stopped with soil alone; but it is also true that others into which the roots had worked were free of earth. From all the evidence I could collect on the spot, I am disposed to consider this stoppage by roots to have originated in the bad laying of the pipes by the farmer, and insufficient depth in a very foul piece of land. It is, however, a case of warning, and one to excite vigilance of observation."

Both theory and practice are greatly at variance as to the proportion of the costs of draining which ought to be paid by respectively the landlord and the tenant. A few persons contend that landlords ought to pay the whole; a few, that tenants, holding long leases, ought to pay the whole; some, that the state ought, in a great class of instances, to pay a considerable or even a large proportion; and multitudes, that the landlord and the tenant ought jointly, but in very variable relative proportions, to pay the whole. One of our most judicious speculators on the subject, Mr. Smith of Deanston, contends that the landlord ought to pay two-thirds and the tenant one-third; and another of our most judicious speculators, Mr. Roberton of Ladyrig, makes statements and calculations which appear to inculcate the very reverse of Mr. Smith's proportions, assigning one-third to the landlord and two-thirds to the tenant. A few patriotic landlords have, over large portions of their estates, not only borne all the costs of draining, but designed or superintended its principal operations; and not a few niggardly, skin-flint, purblind landowners, have hitherto refused to bear even a fraction of the cost,—while some are such screws as to deny even the slight inducement of a remuneratingly long lease. In some instances, the landlord provides the materials, and the tenant executes the work; in others, the tenant, upon a long lease, bears one half of the total expense, and the landlord the other half; and in others, upon a long lease, the tenant carts the materials and pays 5 per cent. on the total expense, and the landlord pays, not only for all the materials, but for all the operations. In some places, the valuation for draining extends to ten years,—in others, to twelve years; and when it is made at any interval between the finishing of the work and the final term, a proportion is deducted according to the time which has elapsed,—one-tenth for every year of the ten-year system of valuation, and one-twelfth forevery year of the twelve-year system.—*Stephens' Practical Irrigator and Drainer.—Johnstone's Treatise on Draining Land.—Anderson's Essays on Agriculture.—Smith's Remarks on Thorough Draining.—The Bath Papers.—Edinburgh Encyclopædia.—Monteath on the Draining of Bogs and Marshes.—Reports of the Commissioners on the Bogs of Ireland.—Sir John Sinclair's Code of Agriculture.—Sir John Sinclair's General Report of Scotland.—Davy's Agricultural Chemistry by Shier.—Knowledge Society's Treatise on British Husbandry.—Buel's Farmer's Instructor.—Watson's Forester's Manual.—Doyle's Cyclopædia of Husbandry.—Stephens' Book of the Farm.—Bayldon on Rents and Tillage.—Lowe's Elements of Agriculture.—Rham's Dictionary of the Farm.—Marshall's County Reports.—Journal of the Royal Agricultural Society of England*, Vols. i, ii, iii, iv, v.—*The Farmer's Magazine.—The Irish Farmer's Journal.—The Gardener's Gazette.—The Quarterly Journal of Agriculture*, Nos. 13, 14, 22, 25, 26, 30, 31, 34, 38, 39, 40, 42, 43, 45, 46, 48, 49.—*Transactions of the Highland Society, attached to Quarterly Journal of Agriculture*, Nos. 4, 5, 7, 8, 13, 37, 38, 49, 50, 51, 52, 53, 54, 55, 58, and *New Series*, No. 2.

DRAPE. A farrow-cow or farrow-ewe; that is, a cow or an ewe who has recently ceased to give milk.

DRAUGHT. The traction or dragging of a vehicle, implement, machine, or weight, by either animal or mechanical power; or the amount of resistance encountered and overcome by that power in dragging. The principles of mechanical philosophy involved in draught, and the exceedingly diversified application of these principles in practice would form far too long and intricate subjects of discussion for our available space. But any reader who feels curious respecting them may find them amply and luminously discussed in an essay appended to Mr. Youatt's Treatise on the Horse; and all our practical readers will probably think they have quite enough upon them in our articles **Carriage**, **Cart**, and **Wheel**.

In all draught of wheeled vehicles, whether carts, waggons, or whatever else, four great provisions are necessary in order to prevent a wasteful expenditure of the dragging power, or in order to obtain the maximum use of that power in the transmission of weight,—first, that the road or other surface dragged upon should be as firm, smooth, and level as possible, and should have no more curvature than is necessary for preventing the stagnation of water; second, that the wheels should be as nearly cylindrical and vertical as possible, and should have as ample a circumference as convenience can admit; third, "that there should be a firm, unyielding connexion in the direction of the movement between the power employed, the weight moved, and the wheels,—in other words, that the force should always act directly and without elasticity both upon the load and upon the wheels;" and fourth, that as much elasticity as possible should, by means of springs, be vertically interposed between the wheels and the body of the vehicle, so that the wheels, in passing over ruts, stones, and other irregularities of surface, may occasion as few and gentle shocks and jerks as possible to the load. The first of these provisions is by far the most effective,—for a mere slight dirtying of a good turnpike road has been proved to diminish or waste the power of draught to the amount of one-third of its whole force,—a soft sandy road has been proved to require seven times more force for the traction of any given weight than a clean, firm, level turnpike road,—and the prodigiously accelerating effect of the perfectly firm, smooth, and level surface of rails is now familiar to almost every school-boy; hence the vast importance, in order to the economizing of draught or of horse-labour, of maintaining all the roads of a parish and the road-ways of a farm in the firmest and smoothest condition which circumstances will admit. See the article ROADS.

Draught in the thrashing machine is the most severe labour to which farm horses are subject; and it ought to be studiously and nicely adjusted to the economizing of their strength. The old-fashioned ring-chain, with the draught-chains simply attached to it at regular distances, was divided by these distances into a square, a hexagon, or an octagon, according to the number of horses; and as the draught-chains were passed over pulleys to bring them to the yoking point, the horses pulled against one another; and only so long as the ring or main-chain preserved a figure having equal angles, whether a square, a hexagon, or an octagon, just so long had the horses an equality of draught. Whenever one horse, from either weakness or laziness, relaxed a little of his force, some other of the horses or all of them were necessarily urged into as much super-exertion as would be requisite to supply his deficiency; and the angles of the figure of the ring-chain now becoming changed, the feeble or lazy horse, by virtue of the law of oblique forces, acted in resistance of the power of the other horses. But a method invented about 8 or 9 years ago by Mr. Christie of Rhind in Fifeshire, gives immutability to the figure of the ring-chain, and makes such attachment of the draught-chains that, when any horse either slackens his pace or starts ahead, the only effect is the diminution or the increase of the extent of the loop by which he draws, and the counter increase or diminution of the extent of the loops by which the other horses draw; and the force exerted at each angle, or the actual power exercised by each horse, remains precisely the same as before. This new method, too, places its principles so completely within range of calculation or of geometrical definition, as to be capable, by means of very slight and simple modifications, of apportioning different degrees or proportions of the draught to different horses, so as to distribute the whole in adaptation to their various strength. When the pulleys of the draught attachments are so fitted as to move outward and inward in reference to the centre of the wheel at pleasure, and to be capable of being fixed at any point, then may a distribution of the whole draught among the several horses, according to their respective strength, be made with comparative certainty and uniformity, and without even the smallest liability to change or fluctuation from unsteadiness in the pace or traction of any of the animals. Thus whether horses of equal strength or horses of unequal strength be yoked in the thrashing-machine, the whole of their force may be thoroughly economized.

The draught of *ploughs* is a subject of quite as much interest to farmers as the draught of carts or the draught of the thrashing-machine. A series of interesting experiments was made in 1840, by Philip Pusey, Esq., with the view of ascertaining the comparative draught of ploughs of different construction; and it was rendered very definite in its indications by the use of an excellent dynamometer, and the combined observation of a number of experienced practical judges. The ploughs tried were Ferguson's improved, iron, Scotch swing-plough; Clark's improved Scotch swing-plough; Hart of Wantage's one-wheeled plough, of wood with iron breast; Ransome's FF plough, with two wheels; Ransome's FF plough, wanting the wheels, and used as a swing-plough; a Berkshire wooden-breasted swing-plough; a Berkshire heavy one-wheeled plough; Ransome's Rutland plough; an old Berkshire plough, very cumbrous, wholly of wood, with an extremely high gallows in front; and the Holkham two-wheeled plough, with a light gallows.

These ploughs were first tried, with a furrow of 5 inches deep and 9 inches wide, on a field of sandy loam, in a wet condition, and of such texture as to be freely worked; and Ferguson's Scotch swing was ascertained to have a draught of 19 stones, Clark's Scotch swing 20 stones, Hart of Wantage's 14 stones, Ransome's two-wheeled FF 14 stones, Ransome's swing FF 18 stones, the Berkshire swing 18 stones, the Berkshire one-wheeled 17 stones, Ransome's Rutland 17 stones, the old Berkshire 23 stones, and the Holkham two-wheeled 18 stones. They were next tried with a furrow 6 inches deep and 9 inches wide, upon a clean bean stubble of dark mould, upon a subsoil of blue clay; and Ferguson's Scotch swing was proved to have there a draught of 50 stones, Clark's Scotch swing 52 stones, Hart of Wantage's 43 stones, Ransome's two-wheeled FF 44 stones, Ransome's swing FF 44 stones, the Berkshire swing 48 stones, the Berkshire one-wheeled 43 stones, Ransome's Rutland 50 stones, and the Old Berkshire 52 stones. They were afterwards tried, with a furrow of 5 inches deep, upon a very poor, damp, moory soil, in a state of grass lea, but with thin uprooted grasses and more than half-bare surface; and Ferguson's swing had there a draught of 23 stones, Clark's swing 23 stones, Hart of Wantage's 16 stones, Ransome's two-wheeled FF 14 stones, Ransome's swing FF 21 stones, the Berkshire swing 19 stones, the Berkshire one-wheeled 18 stones, Ransome's Rutland 21 stones, and the old Berkshire 25 stones.

Upon these trials and a number of others, upon different soils and in different methods, Mr. Pusey makes the following summary report: "With regard to the question of wheel and swing ploughs, wherever the soil is firm enough to bear up the wheels, they appear to me to be advantageous: the best plough therefore will be one the wheels of which can be taken off or put on, according to the state of the ground; and as, where there is one wheel only, it will be on the unploughed ground, where it will be less likely to become clogged, one wheel only is probably better than two. It may be fairly said that the lightest plough in these trials was Hart's, though Ransome's FF ran it exceedingly near, and beat it in the last trial. The best and lightest plough on a wet clay was the Berkshire swing with a wooden mould-board. Hart's plough on our lighter land goes as easily with two horses, and the Berkshire on wet clay with three horses, as our old Berkshire with three horses on the former ground, and with four on the latter. These two ploughs have the open mould-board; but how far that contributes to their excellence, I cannot discover. Ransome's Rutland plough appears to be a very good implement, the Scotch swing plough to be the heaviest of all the modern ploughs which were tried, not to make a clean furrow, to be out of the question upon any light soil, and to be by no means the best upon a heavy one."

The average draught of all the ploughs in different soils as showing the comparative tenacity of these soils, and the respective power required to work them, is a subject of much practical interest; and this, in making a furrow 5 inches deep and 9 inches wide, was 16⅘ stones in loamy sand of coral rag, 17⅘ stones in sandy loam of coral rag, 20 stones in moory land of alluvial gravel, 28⅘ stones in clay loam of Kimmeridge clay, 31⅗ stones in strong loam of Kimmeridge clay, and 47⅕ stones, but with a furrow 6 inches deep on one side, though with the furrow-slice thrown downward, on clay loam of Oxford clay. —Draught with two horses abreast was clearly ascertained to be ample and advantageous on all light soils; but whether sufficient for heavy soils depends on the structure of the plough, the comparative strength of the animals, and the particular contrivance in the mode of their attachment. Two horses abreast, when yoked to the plough by the shortest possible method of attachment, appear to have quite or very nearly as much power as three horses in line; and when pulling a plough of light draught, they may, with equal ease to themselves, perform as much work as four horses pulling a plough of heavy draught.

The effect of difference of speed, and the prodigiously greater retarding power of friction than of cutting, are likewise topics of much practical interest. These two points are simultaneously reported on by Mr. Pusey; and the former was ascertained by experiment on the moory land, with Clark's Scotch swing plough, drawn by a pair of very fine Clydesdale horses. "The Scotch horses," says Mr. Pusey, "were made to go along the 5 and the 6 inch furrows, at the slowest pace to which they could be restrained,—not so slow a one, however, as I have lately seen in other horses at the same work. The draught was 24 stone in the 5-inch furrow, and 22 in the 6-inch one, which I suppose was on lighter land. They were next urged to the utmost speed of their walk, more than double their former rate; but though more than a double quantity of land was of course ploughed in the same time, the draught was only raised from 24 to 25 or 26 stones in the one furrow, and from 22 to 23 in the other. The extreme slightness of this increase would have surprised me still more, had I not learned in the course of these trials how large a portion of the draught of the plough is occasioned by its friction against the soil, how small a part by the splitting, raising, and throwing over a certain weight of earth. Thus, in the trial at Lyford, a bystander pointed out to me that, while one of the ploughs was being accidently drawn down a furrow already opened, such was the adhesion of the clay, that the gauge actually marked as high a draught at that time as turned out afterwards to be the average of the plough's work in the same field. Now, friction is, I believe, often not increased by increased rapidity of motion in the two bodies rubbing against each other. But in the draught of the plough, we have its own weight pressing against the bottom of the furrow, and that pressure increased by the weight of the furrow-slice, the latter weight not increasing whatever the pace may be; we have also the plough rubbing against the earth on the land side, and the furrow-slice rubbing strongly against the mould-board; all these parts of the draught coming under the head of friction, which may not be increased by increase of speed.

But though we have thus given a continuous view of the results of Mr. Pusey's experiments, we consider them to be valuable more in a suggestive sense than in an instructive one, and cannot regard them as conclusive on even the question of absolute draught, and still less on that of the comparative power of wheel ploughs and swing ploughs. Both a review of them by a special Committee of the Highland Society, and a testing of them by sets of very carefully conducted experiments in Scotland have shown, that, though deserving great attention for their suggestions, they must be but loosely relied upon for their results. A swing-plough may be made lighter than a wheel-plough to just the amount of the wheel's weight; it is a less complex machine in precisely the proportion of its wanting the wheel; it can be quite as easily managed by any properly trained ploughman; it possesses the eminent advantage of allowing the workman to vary the depth of his furrow at will, or in unavoidable adaptation to obstruction; and it has been found, from long and extensive practice, to perform, on the average, better and more daily work in the lowlands of Scotland than the swing-plough performs in Yorkshire and in some other English counties. See the article Plough.

A set of very nicely performed experiments upon plough-draught was conducted, in October 1840, at Rozelle in Ayrshire, with eight select ploughs, in the presence of a deputation of the Highland Society, the curator of their museum, and a great concourse of very skilful agriculturists. The ploughs were three of Wilkie's swing ploughs, respectively 175 lbs., 196 lbs., and 159 lbs. weight, and each made wholly of iron; a Ransome's FF plough, with a wheel under the fore part of the beam, the plough itself 155 lbs. weight, and the wheel 6 lbs. weight; a Palmer's patent plough, with one wheel under the fore part of the beam and another wheel in the heel, the plough itself 225 lbs. weight, and the wheels 6 lbs. weight; a London swing-plough of wood, with cast-iron mounting, 189 lbs. weight; a Sussex turn-wrest plough of wood, with cast-iron mounting, of unreported weight; and a Wilkie's turn-wrest plough, wholly of iron, and 203 lbs. weight. All the ploughs were tried, with a furrow 6 inches deep and 9 inches wide, in a two-year-old grass field, of strong clay loam, on a subsoil which was naturally a stubborn clay, but which had been thorough-drained and subsoil-ploughed; and five of them were tried, also, with a furrow of the same dimensions, on a bean-stubble field of much lighter soil. The draught, on the lea land, of Wilkie's first swing was 38 stones; of Wilkie's second swing 37 stones; of Wilkie's third swing 40 stones; of Ransome's FF wheel-plough, both with the wheel and without the wheel, 32½ stones; of Palmer's patent two-wheeled 40 stones; of the London swing, 40 stones; of the Sussex turn-wrest, 48 stones; and of Wilkie's turn-wrest, 46 stones;—and the draught, on the stubble land of Wilkie's first swing was 23 stones; of Wilkie's second swing 24 stones; of Ransome's FF, with the wheel, 21 stones; of Ransome's FF, without the wheel, 20 stones; of Palmer's patent, with the wheels, 22 stones; of Palmer's patent, without the wheels, 20½ stones; and of the London swing, 22 stones. Three great and edifying facts appear in these results,—that the resistance or draught of the ploughs is by no means proportionate to the weight of the implements,—that the comparative powers of different ploughs are greatly altered by difference of soil,—and that the wheel ploughs acquired no advantage from their wheels on the lea land, and were positively encumbered by them on the stubble land. But a chief inference from these experiments, from Mr. Pusey's and from others which we could relate, is, that, while some ploughs are in all aggregate circumstances far superior to others, the best for one kind of soil is not the best for a second, and the best for the second kind of soil is not the best for a third; so that thorough economy of plough-draught, on a farm of diversified soils, or on a farm whose lands are subject to great variety of mechanical conditions, is unattainable with ploughs of only one construction.—*Youatt's Essay on Draught.—Journal of the Royal Agricultural Society of England.—Transactions of the Highland Society.—Quarterly Journal of Agriculture.—Stephens' Book of the Farm.*

DRAUGHT. A medicinal drink. See Drench.

DRAUGHT-HORSE. See Horse.

DRAW-HOE. See Hoe.

DRENCH. A draught or medicinal drink, administered to a horse against his will. It is often preferred to a ball in flatulent colic and other cases in which the medicine requires to act with the utmost possible rapidity; and it may consist of water, ale, and other liquids as menstrua according to their respective adaptation to the particular conditions of either the disease or the medicine. A drench ought rarely, if ever, to exceed a quart; and, in all ordinary causes, it may be administered by an expert operator with a strong, smooth-necked, wide-mouthed bottle, and by an inexpert operator with a cow's horn,—the animal, in either case, being placed in a reversed position in his stall, and having his head held firm in an elevated posture. But a drench is always, in some degree, a dangerous method of exhibition; it is frequently a bungled and consequently inefficient one; and it is never absolutely necessary except in diseases which oblige the animal to lie, and may then be far more safely and efficiently administered to him in his licing posture. Every pungent or disgusting draught is in particular hazard of finding its way down the wind-pipe, and exciting inflammation in the lungs; and no drench ought to be administered to an animal, unless he be in danger of dying without it.

DRESSING. The ploughing and cleaning of fallow land. Five ploughings are usually reckened for a clean fallow; and, on loamy land, are estimated to cost about £3 per acre. The first dressing is a winter ploughing of the land, followed by the grubbing of fences and the clearing of ditches; the second is a spring ploughing, followed by six tines of harrowing, by rolling, and by couching; the third, is a cleansing ploughing, followed by four tines of harrowing and by rolling; the fourth is the ploughing with the manure; and the fifth, is the seed-furrow, accompanied with three tines of harrowing, with water-furrowing, and with grooping. When valuation is made for the cost of dressings to be paid by an incoming tenant, the judges make a higher or a lower allowance according to the comparative practicability of the soil, and a full or partial allowance according to the completeness or the slovenliness of the fallow; and should they find that, after one or two dressings, the land has been neglected, so as to have reverted to its foul condition, they make no allowance whatever.

DRESSING. A dispersed and superficial application of manure. This, however, is sometimes, and far more properly, called top-dressing. See the article Top-Dressing.

DRIFT-SANDS. See Downs.

DRILL. A straight mimic furrow in tilled land, for the reception of seed. Any one drill is of uniform depth and character; but drills, in general, are of very various depths to suit the different kinds of seeds deposited. The sowing of seeds in drills is called drilling; and the prosecution of this practice in the farm is called drill-husbandry. See next article.

DRILL-HUSBANDRY. The sowing and cultivating of field-crops in regular and equidistant rows. Drilling has, from time immemorial, been practised in the garden; but, except in the case of rice and of some other crops of warm countries, it is quite a modern practice in the field. The celebrated Jethro Tull adopted it, with the view of facilitating the execution of his theory as to the minute pulverizing of the soil; and as his husbandry was mainly distinguished by the plying of the horse-hoe between the drills, and adopted the practice of drilling only as an aid to horse-hoeing, it popularly assumed the designation of the horse-hoeing husbandry. Had field drilling been commenced on its own merits, with horse-hoeing merely as an accessory, it could scarcely have failed to recommend itself to speedy general adoption; but, in consequence of being commenced as, not the principal, but the accessory, it unjustly suffered, in popular estimation, all the suspicion and ridicule which arose from the pervading error of Tull's system, as to the feeding of plants from the mere pulverulence of the soil. The Scotch, so early as 1760, adopted drilling and horse-hoeing in the cultivation of turnips; but the English were very slow to show any favour to any part whatever of "the new husbandry," the Irish are but slowly beginning in the present day to be tolerably acquainted with it, and not even the Scotch have as yet given it fair consideration in the cultivation of corn crops.

The drilling of leguminous crops, on ordinary soils, and especially on wet soils, is peculiarly advantageous for exposing a comparatively great surface to atmospheric influence, for destroying weeds, for aerating the ground, and for preventing the stagnation of water, or the impeding of a sweet, free, and rapid circulation; yet it is quite unsuited, or might be positively injurious, to such very dry soils and situations as should expose the raised ridges to an excessive deprivation of moisture. The drilling of beans, in all sorts of strong soils, whether loam or clay, affords the great additional advantage of an abundant ventilation among the pods of the lower and middle portions of the stems. The drilling of pease, either by themselves or with a mixture of beans, has produced as clean and healthy crops in the fields as are usually obtained in gardens; but it requires the frequent use of the hoe along the intervals, and careful hand-weeding among the plants. The drilling of tares, especially of spring-sown tares, if accompanied and followed by a free use of the hoe, will, in dry seasons and upon ordinary soils, render the crop more profitable than a crop of beans. The drilling of turnips affords such supereminent facilities for singling, for hoeing, and for the entire culture, as to be readily appreciated by minds which are too obtuse or too prejudiced to see the higher advantages of the stirring and aerating of the soil. The drilling of potatoes is almost as obviously advantageous as the drilling of turnips; but requires to be practised with such wide intervals between the drills as to allow ample scope for the passage of plough and hoe, and not to permit the radical fibres to be disturbed by the horse-hoeing. The drilling of carrots, beet, or mangel-wurzel, on either shallow or stiff land, has the eminent advantage of making artificial ridges of soil, and of giving the plants a depth of scope and a porosity of bed vastly greater than they could enjoy upon plain land; but, like the drilling of potatoes, it requires an amplitude of interval between the drills. The drilling of borecoles and cabbages, almost suggests itself as a matter of course, and scarcely needs to be recommended.

The advantages of drilling grain crops are as real and quite as great as those of drilling green crops; but, in consequence of their being liable to some important exceptions, and of their never being so obvious to the eye, they have hitherto failed to secure general attention and acknowledgment. So long ago as in 1799, they were very fully and convincingly stated in an article in the Bath Papers; and at an agricultural meeting at Holkham in 1819, they were submitted in the following terms by Sir John Sinclair:—"1. The draining of culmiferous or grain crops, when it is conducted with skill and attention, is a practice in general highly to be approved of, as the seed is thus deposited in the soil with great exactness in respect of depth, regularity, and proportion, and is so placed that the crop can afterwards be improved in its progress towards maturity. In moderately rich soils, there may be also a saving of seed sufficient to defray any extra expense attending the drill system; but the extent of that saving must depend upon the fertility of the soil.—2. In light soils, drilling has the important advantage of giving the grain a good hold of the ground, and of giving all the seed the same hold, which prevents the frost from throwing out the plants in spring, or the wind from loosening the roots after the stem gets high, or when the ear is filling.—3. The progress of the plants after the land has been stirred in spring, is in the highest degree surprising, even in wet districts, and in dry climates the process must be still more beneficial.—4. The expense of cutting down a drilled crop in harvest, is uniformly less than one which is sown broadcast; for three reapers will do as much work in the former case as four in the latter.—5. With a view merely to the extirpation of weeds, drilling autumn or winter sown wheat is not essential, as the ground may be previously cleansed by a summer fallowing, when that practice is adopted; but that it is highly important to be enabled in spring to pulverize the ground between the rows of drilling wheat, for the reception of clover seeds; and that with drilled grain, the succeeding crop of clover must always be superior, both from the freer admission of air, and as the corn is less apt to be lodged or beat down in wet seasons.—6. In stony, wet soils, and in moist seasons, sowing broadcast may often be necessary, and then drilling will not answer so well, unless the ridges are carefully ploughed in autumn, or early in winter, to the exact breadth which suits either one or two movements of the drill machine; and unless in spring, the land is merely scarified or harrowed, (the winter's frost having rendered it sufficiently friable,) and the corn is drilled by a machine drawn by a horse walking in the furrows.—7. Crops, when drilled, are some days later in ripening, and in very gravelly or stony soils, or in undulated districts, where the land is deep, or when a crop is taken after lea, or where the land is not in the best state of tilth, drilling cannot be executed with the regularity and exactness that is required to insure the success of that operation. —8. In highly cultivated soils, either thoroughly cleansed, or where the crops are so luxuriant as to overpower all annual weeds, sowing broadcast possesses advantages over drilling, the seed being scattered more evenly over the land, and the roots not being so matted together as when drilled. In very rich soils, also, the hoeing is apt to throw the vigour of the soil into the stems or foliage instead of the fruit. Hence, though the straw may be strong and abundant, the grain is apt to be defective in quality, and diminished in quantity.—9. In very rich soils, crops sown broadcast, and covering the whole surface, are more likely to be abundant, than when only a part of the soil is productive.—10. On all lands where annual weeds are abundant, white crops, sown in spring, may be drilled with advantage, for the purpose of cleansing the land more effectually, and at a cheaper rate than hand-hoeing and hand-weeding broadcast crops. The lands of moderate or inferior quality will thus yield a greater produce, and may be brought more nearly on a footing with fertile lands than under the broadcast system; hence the drilling of crops in such soils cannot be too strongly recommended as a most important national object." The exceptions made in the 7th and the 8th of these statements have been found fewer and smaller in practice than as they are there stated; and those of the 8th statement, in particular, can occur in any visible degree, or even can occur at all, only in cases of too wide intervals or of too thin sowing. Two considerable advantages which the statements but slightly touch, are the saving of seed and cheap harvesting; and a very great advantage which they nowhere directly mention, is the superior size and strength of both the culms and the heads of the crops.

The main objections to the drilling of grain crops, and the reasons why this great practice is disesteemed in Scotland, are powerfully stated, and we think quite overstated, by the same great writer who so fully exhibits the advantages. "Wheat, rye, barley, and oats," says Sir John Sinclair, "are differently circumstanced, in Scotland at least, in regard to drill husbandry, which, generally speaking, is not considered to be applicable to these grains. The climate is too variable and uncertain, especially at seed-time, to admit of the minute nicety and slow progress which the drill husbandry necessarily requires, without considerable danger of losing the proper season for committing these crops to the ground. The soil is not generally well adapted for this nice operation, requiring to be very equally pulverized, and completely freed from the obstructions of clods or stones, to admit of the ready and accurate operation of the drilling implements. The roots of these grains, so long as any portion of the soil remains unoccupied, are also apt to continue planting out or tillering by means of suckers, by which the advance of the crop towards maturity, and consequently the season of ripening and of harvest, is dangerously postponed. Drilled grain crops, from wanting an equable and general support among their own stems, owing to the distance between the rows, are likewise more liable than those sown broadcast to suffer injury from heavy rains and strong blasts of wind, by which their stems are apt to be broken down irregularly and interlaced among each other, which is technically denominated 'knee-shackled.' Owing to the same circumstances, they are more liable to be root-fallen or wind-waved, their coronal roots becoming disengaged from the soil by a circular motion or waving, from the irregular and changing impulse of the wind, a circumstance which seldom or never happens to a regular close crop. Upon the whole, it is the general opinion of judicious and experienced Scotch husbandmen, after considerable experience in drilling, that more abundant crops of wheat, rye, barley, and oats, may be raised in the ordinary broadcast manner of sowing, than by the drill-machine." [General Report of Scotland, vol. i., pp. 368–9.]

As the drilling of corn crops involves a great number of intricate and complicating considerations, and has been the subject of much conflict and fluctuation of opinion among the best class of farmers, we think ourselves happy to have had the means of exhibiting both the *pro* and the *con* of it, not only in the words, but in the positive opinions, of so princely an agriculturist as Sir John Sinclair; yet we cannot suppress a notion that, had he lived till the present day, he would have exclaimed against the sombre colours of the dark side of his own picture; and we can scarcely hesitate to dismiss the subject in the pithy summary of Martin Doyle, "Though Tull, the originator of the drill husbandry, was ridiculed at first even for drilling potatoes, turnips, and cabbages, his system is now universally pursued with regard to those crops, and there is no doubt of its being equally beneficial in respect to corn crops." Notices of the principal drill-machines will be found in the articles Harrow, Grubber, Dibbling, Turnip, and Sowing-Machines.—*The Bath Papers.—Hunter's Georgical Essays.—Doyle's Cyclopædia of Husbandry.—The Society of Gentlemen's Complete Farmer.—Sir John Sinclair's General Report of Scotland.—Journal of the Royal Agricultural Society.—Quarterly Journal of Agriculture.*

DRIMYS. A genus of exotic plants, of the magnolia tribe. The name signifies "acrid," and alludes to the pungent and aromatic properties of the bark. One of the species, *Drimys Winteri*, called by some botanists *Wintera aromatica*, furnishes the Winter's bark of our drug shops. This plant grows wild in the sunny vales adjacent to the Straits of Magellan, and was introduced about 20 years ago to the hothouses of Britain. It is a large evergreen tree; and has smooth elliptical leaves, milk-white flowers, and light-green berries, spotted with black. Its bark is carminative, stomachic, and antiscorbutic; but is very frequently confounded in the shops with canella alba. Several other species of Drimys are known to botanists.

DRINK. See Drench.

DRINKING-POND. See Pond.

DRIVING. Urging forward domestic animals, whether in travelling or in working. This is often done in so bad a manner as to involve great cruelty to the animals and much loss to the owners. Cattle, when brought out to be driven any considerable distance to market, ought to have very little undigested food upon their stomach; and, when upon the road, they ought to travel leisurely, and never be driven into either fatigue or excitement, never seriously heated, never much urged, never beaten, never allowed to make any spontaneous run or hasty movement, never over-gorged with food, and always, as nearly as possible, maintained in the same cool and easy condition as if they were moving about on their summer pastures.

Sheep, when about to be driven to market, should be selected, turned upon a piece of coarse dry pasture, examined in their hoofs, and ochre-marked on the shoulder, rump, or other parts of the body; when collected for the road, they should be in a medium state between repletion and hunger; and, when on their journey, they should be driven slowly and coolly, 3 or 4 miles on the first day, and about 8 miles on every following day, and should be restrained and controlled by an experienced and cautious dog, and should enjoy, during the long interval of daily rest, an ample and quiet piece of pasture.—The driving of pigs is difficult, and perhaps ought not to be attempted. One excellent method of getting them along, is sparingly and warily to drop beans upon the road; and if this method be conjoined with due care to prevent the head ones of the drove from bolting off, it will be incomparably more successful than any mode of mere driving.

The driving of horses in waggon-draught, and especially in cart-draught, requires much attention, great care, and considerable kindness, and is, in a deplorable proportion of instances, very ill or even very cruelly performed. The driving of cart-horses on the streets and in the neighbourhood of large towns, in particular, is often performed in a manner altogether heartless or savage. Constant urging, frequent whipping, occasional kicking or striking, and general inattention to the several methods of averting pain, or of alleviating labour, are so often the characteristics of horse-driving in cities as to have been a main cause of procuring for Britons, among our continental neighbours, the atrocious reputation of being the most cruel nation in Europe. A good driver sees that both the yoke and the load are properly adjusted; he avoids ruts and inequalities upon the road; he makes gradual deflexion in order to pass vehicles and obstructions, and uses general precaution against any jerk or sudden change of motion; he pursues an oblique line in winding upon an acclivity or upon a rough or adhesive level; he keeps constantly beside his horse, and never rides on his cart or waggon when it is laden; he makes any occasional alterations in the centre of gravity which are requisite to equalize either the draught or the pressure; he does not permit his horse to stand with a strain upon him on a declivity; he forbears, except in extreme cases, all use of the whip; and, in general, he acts with kindness, with consideration, and with a steady regard to both the comfort of the animal and the economizing of his labour. Such a man takes more work out of an inferior horse than a bad driver can get out of a superior one; and he, at the same time, prevents all the outrage upon good moral order, and all the enormous indirect injury to society, which arise from the practice of cruelty.

DRONE. See Bee.

DROP-DRILL. See Bone-Manure and Turnip.

DROPSY. A watery and diseased swelling in some parts of plants. It occurs chiefly in plants of a succulent nature, and principally in bulbs, tubers, and fruits. It appears to arise from the absorption of more moisture by the spongioles than can be secreted in the plant or thrown off by the leaves; and it is known to be caused by excessive manuring, excessive artificial watering, and an unusual abundance of rain. Bulbs and roots affected with it are watery and swelled; fruits are watery and insipid, and fall before being ripe; and leaves, though continuing green and apparently sound, suddenly and prematurely fall.

DROPSY. The morbid and excessive secretion of serous matter in the abdomen of man or of the domestic animals. Dropsy in the horse is sometimes so extensively understood as to include hydrocephalus or water in the head, hydrothorax or water in the chest, hydrops-pericardii or water in the pericardium, anasarca or water-farcy, partial œdema or swelled legs, and ascites or water in the belly; but, both for the sake of method, and in order to accord as much as possible with popular nomenclature, we understand it exclusively in the last of these senses. Abdominal or true dropsy in the horse, is seldom a primary affection, but not infrequently results from some other diseases, particularly those of the kidneys, the liver, and the smaller intestines. Its usual symptoms are swelling of the abdomen, decrease of urine, a degree of costiveness, and much disinclination to exertion. When only a symptomatic or secondary disease, it can seldom if ever be successfully attacked; yet, when a primary disease, or when in favourable circumstances a secondary disease, it may be treated by tonics, aperients, smart diuretics, prolonged frictions, frequent and gentle exercise, warm clothing, and well-timed, judicious tapping.

Dropsy in the cow is sometimes so acute and rapid as fully to pass through all its stages, and to kill the animal, in the course of two or three days; and whenever it assumes this very acute character, it may be regarded as incurable. Chronic dropsy in the cow, on the other hand, is sometimes of such slow development as to effect enlargement of the abdomen no more rapidly than ordinary improving of condition; and it is distinguishable to the eye from hoove and from flatulent colic by its causing an enlargement, not of the side, but of the whole belly,—and from improvement of condition, by its being accompanied with lassitude of system, dryness of skin, roughness of coat, either emaciation or puffy swelling of limb, excessive thirst, and alternate costiveness and diarrhœa. A complete cure can rarely be effected; and the most economical treatment for the owner, as well as not the least humane for the animal, is to reduce the enlargement by tapping, to improve the health and condition by means of tonics and diuretics, and then to part with the brute as soon as she is rapidly and pretty well improved. Torturing a dropsical cow with thirst, is sheer cruelty, and has no sort of sanative effect.

Dropsy in sheep—or water-sickness, as many shepherds call it—is occasioned variously by constitutional debility, by bleakness of pasture-ground, by too free use of turnips and succulent food, and by accidental circumstances. It occurs most frequently among old sheep, and on bleak pastures. A sheep affected with it fitfully and changefully swells in various parts of the body, becomes dull and languid, and eventually has great and painful distension of the belly. Tapping is sometimes useful in a ewe, but hardly ever of any service in other sheep. Even tonics are of very doubtful value. The chief remedy, or rather palliative, is aperient action upon the bowels, and the substitution of prime, dry, chaff-cut hay for succulent or moist food.—*Blaine's Veterinary Art.—Bartlet's Farriery.—Youatt on Cattle.—Quar. Journal of Agriculture.—Spooner on Sheep.—Journal of the Royal Agricultural Society of England.*

DROPWORT,—botanically *Spiræa filipendula.* A beautiful tuberous-rooted, rosaceous-flowered weed, of the moist meadows of Britain, and particularly of the chalky meadows of England. Its tubers are small, numerous, externally black, and internally white and farinaceous, and seem a group of oval knobs or glandules held together by slender fibres; its stem is round, firm, branched, and about two feet high; its radical leaves spread near the ground, are pinnated, and 7 or 8 inches in length, and consist each of many serrated and almost alternately placed leaflets; its stem leaves are few and small; and its flowers grow in large tufts at the extremity of the branches, have prevailingly a creamy-white colour, and bloom from June till October. The roots have astringent and diuretic properties; and their singular grouping of little tubers is alluded to in the name dropwort. A double-flowered variety of the British plant, and two varieties from continental Europe, are cultivated as ornaments of the parterre.—The name dropwort also belongs to a hardy, perennial-rooted, ornamental, Dahurian plant, of another genus,—*Potentilla filipendula.*

DROPWORT (WATER),—botanically *Œnanthe.* A genus of herbaceous plants, of the umbelliferous order. The hemlock or saffron species, *Œnanthe crocata*, is one of the most poisonous plants of England, to both men and cattle, and ought to be well known in order that it may be carefully avoided. It is very common by the sides of the Thames, and by the sides of ditches and of still streams in very many parts of England. Its roots comprise four or five fusiform knobs, externally resembling parsnips, and sometimes fatally mistaken for them by ignorant peasants; its stem is strong, jointed, hollow, somewhat forked, much branched, and from 2 to 5 feet high; its leaves are doubly pinnate, and have a dark shining green colour, and somewhat resemble those of the hemlock plant, but have a lighter verdure; and its flowers are very numerous and crowded, form large and dense umbels, have a white colour tinged with purple, and bloom from June till August. A fetid and very poisonous juice flows from puncture, wound, or fracture of almost any part of the plant, but is particularly abundant and virulent from the root. The radical juice looks at first like milk, but afterwards assumes a saffron colour; and it contracts, inflames, and ulcerates any part of the human system on which it is allowed to operate,—and has, in many instances, produced violent disease and even sudden death. Horses have been known also to eat the roots and be killed by them. Yet this violently poisonous plant, as found on *Scottish* soil, is said by botanists to be innocuous!

The fistulous species, *Œnanthe fistulosa*, also grows wild by the sides of British ditches and sluggish streams, and has the bad fame of being very poisonous in England, though not with the same virulence as the hemlock species. Its stem is from 2 to 4 feet high; and its flowers are flesh-coloured.—The silaum-leaved species, one-third taller than the preceding, grows likewise in the ditches of Britain; and the pimpinella-like species, a comparatively dwarfish kind, grows wild in the salt marshes of England; but these are not known to be noxious.—Nearly a score of foreign species have been introduced to curious botanical collections; but all, excepting one small evergreen herb from the Cape of Good Hope, are quite or nearly harmless. — The name Œnanthe signifies wine-flower, and alludes to a vinous sort of fragrance, possessed by the flowers of the best known species.

DROSERA. See Sundew.

DROSKY. A kind of light, four-wheeled carriage, first used by the Russians. It is not covered, and its side seats contain a greater or less number of persons. The lower wheels are covered with wings, which keep off the mud.

DROSOMETER. An instrument for ascertaining the quantity of dew which falls. It consists of a balance, one end of which is furnished with a plate fitted to receive the dew, the other containing a weight protected from it.

DROUGHT. Thirst or want of drink in animals; also, a long continuance of dry weather or general want of rain.

DROVER. A person who drives cattle to distant markets. See the article Driving.

DROWNING. A sort of death caused by immersing the exterior opening of the respiratory tube in a liquid. Actual death is often preceded by apparent death, and it is possible, if this state has not continued too long, to resuscitate a person apparently drowned. See the article Asphyxia. This circumstance has led to careful investigations of the nature of drowning, and also, in the neighbourhood of seas and large rivers, to the erection of public institutions for the resuscitation of persons apparently drowned. This kind of death furnishes, likewise, a difficult subject for medical jurisprudence, and gives occasion to the inquiry, whether a body found in the water was actually drowned, or whether life was lost in some other way; and great attention has been paid to the marks of this sort of death, which are to be found upon the body. But, notwithstanding all this pains, much uncertainty still hangs over the subject. This remark is true, as well of the manner in which death is the consequence of immersion, as of the signs of having been drowned, and the means of resuscitating from apparent death. If a person voluntarily immerses his head in water, he perceives a roaring in his ears, a tickling in his nose, a pressure upon his breast, and a kind of stupid feeling. If a man, unable to swim, falls into the water, he instinctively makes every exertion to escape from it; he holds his breath, moves his head up and backward, lays hold of every solid body which presents itself, and even grapples at the bottom of the water. These struggles continue a longer or shorter time, according to the strength and presence of mind of the unhappy subject: at last, he sinks, exhausted, becomes unconscious, strives to breathe, draws in water, and life is gone. If the body is taken from the water, it is commonly found to be very cold; the limbs are stiff, the countenance distorted, livid, and often pale, the eyes half open, the pupils enlarged, the mouth filled with foam, the breast and region of the upper stomach expanded. Sometimes the body is still warm, though it cannot be reanimated, the countenance blue and distorted, the veins of the neck much swollen. This takes place when one is drowned in alcohol, or in marshy or warm water, or when a person, in a state of intoxication, or with a full stomach, or a heated body, falls overboard. On opening the body of a person who has been drowned, the epiglottis is found to be raised, bloody foam appears in the windpipe and bronchial passages, the lungs are soft and distended, a large quantity of black fluid blood is collected in the right, and less in the left cavity of the heart, a little water is in the stomach, and the vessels of the brain are swelled with blood. Death is sometimes caused by suffocation and want of air, and sometimes as in apoplexy: in the latter case, it happens very speedily, and a little water is sufficient to produce it, if the person falls upon the face. In this case, when the body is opened, the foam in the windpipe is wanting, and the vessels of the head are fuller. The various constituents of the water, such as irrespirable gases, contribute also to modify and complicate the mode of death.

The following are the methods of treatment recommended by the London Humane Society for the Recovery of Persons in a State of Suspended Animation. As drowning is, probably, the most frequent accident by which animation is suspended, we give all the rules of the society here, and shall refer from Freezing, &c., to this article.

Cautions. Lose no time. Avoid all rough usage. Never hold the body up by the feet; nor roll the body on casks; nor rub the body with salts or spirits; nor inject tobacco smoke or infusion of tobacco.

Restorative Means. If apparently drowned, send quickly for medical assistance;—but do not delay the following means:—Convey the body carefully, with the head and shoulders supported in a raised position, to the nearest house. Strip the body, and rub it dry; then wrap it in hot blankets, and place it in a warm bed, in a warm chamber. Wipe and cleanse the mouth and nostrils. In order to restore the natural warmth of the body, move a heated covered warming pan over the back and spine; put bladders or bottles of hot water, or heated bricks, to the pit of the stomach, the arm pits, between the thighs, and to the soles of the feet; foment the body with hot flannels; but, if possible, immerse the body in a warm bath, as hot as the hand can bear without pain, as this is preferable to the other means for restoring warmth; rub the body briskly with the hand; do not, however, suspend the use of the other means at the same time. In order to restore breathing, introduce the pipe of a common bellows (where the apparatus of the society is not at hand) into one nostril, carefully closing the other and the mouth; at the same time drawing downwards, and pushing gently backwards, the upper part of the windpipe, to allow a more free admission of air; blow the bellows gently, in order to inflate the lungs, till the breast be a little raised; the mouth and nostrils should then be set free, and a moderate pressure made with the hand upon the chest. Repeat this process till life appears. Electricity to be employed early by a medical assistant. Inject into the stomach, by means of an elastic tube or syringe, half a pint of warm brandy and water, or wine and water. Apply sal volatile or hartshorn to the nostrils.—If apparently dead from intense cold, rub the body over with snow, ice, or cold water. Restore warmth by slow degrees; and after some time, if necessary, employ the means recommended for the drowned. In these accidents, it is highly dangerous to apply heat too early.—If apparently dead from hanging, in addition to the means recommended for the drowned, bleeding should early be employed by a medical assistant.—If apparently dead from noxious vapours, &c., remove the body into a cool, fresh air. Dash cold water on the neck, face, and breast, frequently. If the body be cold, apply warmth, as recommended for the drowned. Use the means as above recommended for inflating the lungs. Let electricity (particularly in accidents from lightning) be early employed by a medical assistant.—If apparently dead from intoxication, lay the body on a bed with the head raised; remove the neckcloth, and loosen the clothes. Obtain instantly medical assistance, as the treatment must be regulated by the state of the patient; but, in the mean time, apply cloths soaked in cold water to the head, and bottles of hot water, or hot bricks, to the calves of the legs and to the feet.—If apparently dead from apoplexy, the patient should be placed in a cool air, and the clothes loosened, particularly about the neck and breast. Bleeding must be early employed by a medical assistant; the quantity regulated by the state of the pulse. Cloths soaked in water, spirits, or vinegar and water, should be applied to the head, which should be instantly shaved. All stimulants should be avoided.—In cases of *coup de soleil*, or strokes of the sun, the same means are to be used as in apoplexy.

General observations. On restoration to life, a tea-spoonful of warm water should be given; and then, if the power of swallowing be returned, small quantities of warm wine, or weak brandy and water, warm; the patient should be kept in bed, and a disposition to sleep encouraged, except in cases of intoxication, apoplexy, and *coup de soleil*. Great care is requisite to maintain the restored vital actions, and, at the same time, to prevent undue excitement. The treatment recommended by the society is to be persevered in for three or four hours. It is an erroneous opinion that persons are irrecoverable because life does not soon make its appearance; and it is absurd to suppose that a body must not be meddled with or removed without the permission of a coroner.

DRUG. Any substance, whether simple or compound, which is used in regular medical practice. Most kinds of drugs sold in the drug-shops are more or less adulterated; and some are such vile and barefaced counterfeits as can impose only on senseless and unwary clamourers for *cheap* medicines. See the article ADULTERATION.

DRUPE. A fruit containing a nut, or what is popularly called "a stone," within a soft and pulpy pericarp. Familiar examples of drupes are cherries and plums.

DRYAS. A genus of low-growing, hardy, evergreen, trailing, ornamental plants, of the rosaceous-flowered family. The eight-petaled species, *D. octopetala*, grows wild on the rocky mountains of Britain, and is one of the most handsome of our native alpine plants. Its roots are woody and strong; its stems are erect and very short, and form a large, matted, leafy tuft; its leaves are smooth, ovate, nearly an inch long, a dark shining green above, and a rich cottony white below; and its flowers are large and solitary, have a brilliant white colour, and bloom from June till August. A beautiful variety of this species was introduced about 45 years ago from North America, and two other species were more recently introduced from Canada and Greenland. All require peat soil; and the foreign species need a little winter protection.

DRYMONIA. A small genus of very splendid tropical plants, of the gesneria tribe. The two-coloured species, *D. bicolor*, called by Jacquin *Besleria serrulata*, was introduced to Britain, about 40 years ago, from the West Indies. It is shrubby, and of such a climbing habit as to throw out long roots or feelers all the way up the stem; it clings to a wall, and admits of training, in the same manner as the common ivy; it grows with remarkable freedom, and soon establishes itself upon the walls of a stove; its foliage is smooth and a deep green; and its flowers have a pale or greenish yellow colour, slightly spotted with brown, and are very hairy within the tube. A drymonia still brings a very high price in the nurseries.

DRY-ROT. A term or name applied to a rapid decay of any vegetable matter, when it has the appearance of being tolerably dry, but, in general, is applied only to timber when in that state, and is so named in contradistinction to the common mode of decay, by being exposed to the alternate states of wet and dry. There are a great number of causes for this species of decay: some are quite simple, others are very complicated; yet, whatever may be the original cause, simple or compound, the effects are the same, namely, to render the timber useless, by destroying its elasticity and toughness, rendering it insufficient to resist any considerable pressure, and, indeed, for any of the useful purposes to which timber is applied. When timber is in a tolerably dry state, any means which will absorb or extract its oxygen from the other component parts will leave it in the state commonly called *dry rotten*. Moist, warm situations, with little or no current of air, are the most likely to generate this evil. The effluvia from timber in such a state of decay will rapidly carry its effects to the circumjacent timber, however dry it may appear; and any sort of timber will be, in a very little time, rendered quite useless. When timber is exposed to any considerable degree of moisture and heat, fungi of various shapes and texture, according to the species of timber, and other causes, will appear upon it; and although this fungous matter be really an effect of the dry-rot, yet it is as truly a cause of the same evil. There are no means of restoring rotten timber to a sound state, and the dry-rot can only be *cured*, as it is called, by removing the decayed and affected parts, clearing away all the fungi, and destroying its vegetating principle, with which the hard materials, such as bricks or stone, may have been impregnated. For this purpose, a strong solution of iron, copper, or zinc, is used with advantage. This, with the admission of a large quantity of air, is very advantageous. Many persons have written on the subject; and the nostrums proposed are as numerous as their authors. But the only really effectual method of preventing dry-rot is the recently invented and now well-known one which will be noticed in our article KYANIZING. Much also may be done by cutting timber in winter, and properly seasoning it, by steeping it in water for some time, and then thoroughly drying it before it is used in building.

DUCK. A very extensive and natural genus of water-birds, which are found in all parts of the world. It has been divided by naturalists into an infinity of different genera; to such a degree, indeed, that, according to some of the distinctions which have been made, it would be impossible to leave the females of several species in the same genus with the males. The prince of Musignano is of opinion, that they might be advantageously separated into four sub-genera, in which we shall follow him. These are *anser*, or goose,—*cygnus*, or swan,—*anas*, or duck,—and *fuligula*. Thirty-one species of this interesting genus inhabit North America, being within one of the number found in Europe: of these, twenty-one are common to the two continents, leaving ten peculiar to America, and eleven to Europe.

The mallard, or common wild duck, *A. boschas*, is found both in Europe and America. This is the original stock of the domesticated duck, which appears to have been reclaimed at a very early period. The nest is usually placed in the most solitary recesses of a marsh or bog, among coarse grass, reeds and rushes, and generally contains from twelve to sixteen eggs, of a dull greenish-white. The flesh of the wild duck is held in general estimation, and various methods are resorted to, in order to obtain these birds in quantities. In Picardy, in France, vast numbers are taken in decoys, and sold in the Paris market, where, in one season, 30,000 francs have been paid for the produce of the small lake of St. Lambert. They also abound in Lincolnshire, and are there taken in great quantities, by nearly the same means as in Picardy. Pennant had an account sent him of the produce of ten decoys, which, in one winter, amounted to 32,200.

The Muscovy duck, *A. moschata*, is the largest of the duck kind, and approaches nearly to the size of a goose. It has obtained its name from a strong smell of musk, which exhales from its body, and not because it comes from Russia, as has been supposed. The Muscovy ducks are tamed in great quantities in the West Indies, and are found wild in Guiana, where they nestle on the trunks of trees, close upon the water's edge. They feed in the morning upon a plant called wild rice, and seldom permit the sportsman to approach within gunshot.

The canvass-back duck, *A. vallisneria*, is peculiar to North America, and was known to the epicure long before it was described by the naturalist. We are indebted to Wilson for the first account of it. He gave it the name of the plant on which it feeds, and which had been called after the celebrated Vallisneri. The canvass-back ducks arrive in the United States from the north, about the middle of October, and, principally, assemble in the numerous rivers in the neighbourhood of the Chesapeake Bay. On the Susquehannah, they are called *canvass-backs*, on the Potomack, *white-backs*, and on James' river, *sheldrakes*. When they first arrive, they are very lean; but, from the abundance of their favourite food, they become fat about November. They are sometimes found in such multitudes as to cover several acres. From the great demand for these ducks, and the high price they always command, various methods are employed to decoy them within gun-shot. The most successful is that termed *tolling*, in which they are enticed to approach the shore, by means of a dog properly trained. The canvass-back is constantly attended by another species, the widgeon, *A. americana*, which manages to make a good subsistence from his labours. This bird is extremely fond of the tender roots of that particular species of plant on which the canvass-back feeds. The widgeon, which never dives, watches the moment the canvass-back rises, and, before he has his eyes well opened, snatches the morsel from his mouth, and makes off.

DUCK'S-FOOT,—botanically *Podophyllum*. A genus of curious plants, forming with the genus Jeffersonia, the natural order Podophyllaceæ. The plants of this order have a purgative juice, and are nearly related to the white water-lily and to the herbaceous barberries. But only one species of each genus occurs in British gardens. The duck's foot, or peltate May apple, *Podophyllum peltatum*, was introduced, nearly two centuries ago, from North America. Its roots comprise many thick tubers, very vivacious, very spreading in growth, and fastened together by fleshy fibres; its stems are numerous, about 6 inches high, forked, and each sustaining one pinnate leaf, consisting of from 5 to 7 folioles; its flowers are red and nine-petalled, and appear in May; and its fruit have the size and shape of rose-hips, and ripen from a green to a yellow colour.

DUCKWEED,—botanically *Lemna*. A genus of aquatic plants, of the order Fluviales. They belong to the extreme verge of phænogamous plants; and are nearly allied, in simplicity of structure, to the algæ. Four species, all annuals and floating plants, abound in the ponds, ditches, and other stagnant waters of Britain. They have the appearance of small, roundish, leaf-like discs; they are greedily eaten by ducks, and are often propagated by them from pond to pond; and when allowed so to spread as to form a matting athwart the surface of any waters, they speedily occasion the death by suffocation of all the fish which the waters may contain. A number of foreign species are known to botanists.

DUCTILITY. The extensibility and cohesion of particles, which enables metal to be drawn into wire without breaking. The ductility of some bodies, especially of gold, is very surprising. A single grain of gold may be stretched under the hammer into a leaf that will cover a house, and yet the leaf remain so compact as not to transmit the rays of light, nor even admit spirit of wine to transude. But M. Réaumur has shown the ductility of gold to be still greater. What is called gold-wire, every body knows, is only silver gilt. The cylinder of silver, covered with leaf gold, is drawn through the hole of an iron, and the gilding is extended with the wire, to whatever length it may be stretched. Now, M. Réaumur shows, that, in the common way of drawing gold-wire, a cylinder of silver, twenty-two inches long, and fifteen lines in diameter, is stretched to 1,163,520 feet, or is 634,692 lines longer than before, which amounts to about ninety-seven leagues. To wind this thread on silk, for use, it is first flattened, in doing which, it stretches at least one-seventh further, so that the twenty-two inches are now 111 leagues; but in the flattening, instead of one-seventh, it could be stretched one-fourth, which would bring it to 120 leagues. This appears a prodigious extension, and yet it is nothing to what this gentleman has proved gold to be capable of. When glass is penetrated with the heat of fire, it can be managed like soft wax, and may be drawn out into threads exceedingly long and fine. Ordinary spinners do not form their threads of silk, flax, or the like, with half the ease and expedition the glass-spinners do threads of this brittle matter. Some of them are made into plumes, and used in other works; they are made much finer than hair, and bend and wave, like hair, with every wind. Two workmen are employed in making them: the first holds one end of a piece of glass over the flame of a lamp, and, when the heat has softened it, the second operator applies a glass hook, and draws out a thread of glass, which still adheres to the mass; then, fitting his hook on the circumference of a wheel about two feet and a half in diameter, he turns the wheel as fast as he pleases, till it is covered with a skein of glass thread. The parts, as they recede from the flame, by gradually cooling, become more cohesive: the parts nearest the fire are always the least cohesive, and, consequently, must give way to the effort made to draw them towards the wheel. These threads are commonly of a flat oval shape, being three or four times as broad as thick; some of them seem scarcely bigger than the thread of a silk-worm, and are surprisingly flexible. If the two ends of such threads are knotted together, they may be drawn and bent till the aperture, or space in the middle of the knot, does not exceed one-fourth of a line, or one-forty-eighth of an inch, in diameter. The flexibility of glass increases in proportion to the fineness of the threads; and, probably, had we the art of drawing threads as fine as a spider's web, we might weave stuffs and cloths of them, but could never make them long enough to be serviceable. See Divisibility.

DULCAMARA. See Bittersweet.

DULSE,—botanically *Halymenia*. A genus of marine plants, of the algæ order. The eatable and the palmate species, *H. edulis* and *H. palmata*, are well-known as esculent fuci by almost all persons resident upon any of the British coasts; and are, in many districts, gathered in large quantities, not only for edible consumption on the spot, but for sale as a coarse luxury to the poor people of towns. Several varieties of these species, and also four entirely different species occur on our shores; and nearly a score of other species or varieties have been described by botanists. The eatable species abounds in autumn, and the palmate species in winter. See the article Fuci.

DUN. A colour partaking of brown and black. Large dun horses are generally well-tempered, good-feeding animals, neither swift-footed nor very strong, but well adapted to the labours of the farm; but small duns, when somewhat highly bred, suit excellently for the curricle or the phaeton, and when they have a dappling of a darker colour upon their prevailing dun, they are thought to be decidedly beautiful.

DUNG. See Excrement and Farm-Yard Manure.

DUNG-HAWK. A hand-implement for drawing composts and farm-yard manure out of carts upon the fields. It has a handle of about 5 feet in length, and is either a two-pronged or a three-pronged fork, with the prongs formed at right angles with the shaft.

DUNG-HILL. See Compost and Farm-Yard.

DUNT. See Staggers.

DUODENUM. The first of the small intestines of an animal. It communicates from the stomach to the other intestines; it is the largest and shortest of the small intestines; but, in different species of animals, it varies both in its proportional length and in its functional importance. In the horse, it is very large and very important, measuring nearly two feet in length, and performing functions which, in a great degree, are supplementary to those of the stomach. Inflammation of this organ sometimes occurs in the cow.

DURABILITY OF MATERIALS. The following observations and remarks may prove useful. The principal agents of nature in carrying on the work of destruction, are heat, water or humidity, frost, wind, and electricity. Of course the action of all these should be guarded against as far as possible. Heat has a twofold operation: — First, in producing actual conflagration or the consumption of constructions by fire; and, secondly, in expanding the dimensions of all things, thereby altering their figure or shape, and making them perfectly dry, by the evaporation of the natural juices or other humidity they may contain, thus causing them to be more absorbent than they otherwise would be. This latter effect does not require the presence of artificial fire, but is daily going on, under the sun's influence; and as cold contracts all things, so the natural change of temperature that occurs daily, or at any rate annually, is constantly altering the dimensions of things. The first effect of fire, makes it necessary to be very careful in the direction and construction of all flues or chimneys of fire-places, and to guard against their coming into contact with any timber used in the roof or other parts of the building; and of course no timber or combustible matter of any kind should be let into, or be supported by a chimney, or be placed so near to it as to be endangered by the heat. To prevent the passage of fire between the bricks of a chimney, in case of its taking fire, the joints of such brickwork ought always to be laid close and full of mortar, and the inside of the flue should be *pargetted*, the technical name applied to plastering within a chimney. This effectually stops up all crevices or openings through which sparks or flame could pass, and renders the inside of the flue more smooth and even for the passage of the smoke. The expansion and contraction of materials by heat and cold, is a natural effect that cannot be guarded against, except when circumstances admit of the materials that are most subject to it being covered by brick, stone, wood, or other bad conductors of heat, or such as transmit it slowly or imperfectly; in which case they will be much less affected. Those substances that conduct heat most rapidly, are also those that are most subject to expansion and contraction; consequently, this effect does not prevail to any sensible or detrimental extent in stones, bricks, mortar and the earths; but it is quite perceptible, and requires to be guarded against in the metals, particularly when used in a long continuous length, as in the construction of iron bridges, or laying iron pipes for conveying water long distances. Another species of expansion and contraction frequently occurs in bodies that are not metallic, arising from their hygrometrical properties when damp and dry. This belongs more especially to some varieties of wood. Wood is not subject to any material alteration in the length of its fibres from this cause, but it operates very perceptibly in the opposite direction. Wood and most vegetable substances always shrink to a certain extent by drying, and swell or expand to their former dimensions, or nearly so, when wet or humid. This property gives tightness to casks, vats, or tubs for holding water, and it causes the boards used in floors, doors, or joinery work, to expand and become tight and close in damp weather, or to shrink when dry. This effect in vegetable matter diminishes with age, and its prevention is one of the uses of seasoning timber, and keeping it a long time before it is used.

Water, or rather humidity, is the great and general cause of decay in materials. It acts as a solvent, if the substance contains anything that is soluble; and in this way, or by the motion of water, parts of the material are abstracted and carried away. It also acts chemically in producing fermentation, decomposition, or decay, commonly called *rotting;* and it encourages and promotes the production of certain fungi, or parasitical plants which destroy the texture and hasten decay. Notwithstanding this character has been given to water, it belongs more properly to water and air conjoined; for neither of them act powerfully, or rapidly, when separate. Thus a piece of sound timber, or a bar of iron, if exposed to the free action of air that is perfectly dry, will endure for ages without symptoms of decay; but if timber or iron are occasionally wet and dry, the first will decay in a few years, and the latter will speedily contract rust, which gradually eats into it, until its whole substance is destroyed. The more rapidly a substance can become dry after it has been wetted, the less likely it will be to be affected by decay; hence, whenever humidity is retained, it never fails to operate prejudiciously. Wooden, and even iron posts, always fail first near their bottoms, because the natural humidity of the ground, or even the moisture that may fall upon a horizontal floor or platform, assists in the operation. The sun's heat, by drying and expanding timber, causes it to become much more absorbent of water than it otherwise would be, and if the water so absorbed is not permitted to escape freely, it never fails to produce decay. The great object to be attained by painting external wood with oil colours, is, therefore, preservation more than ornament, for if the paint is good, it ought, when dry, to form a coat or casing that is impervious to water, or even humidity, and when that is the case its preservative powers are well known. For this reason, paint should never be applied to work that is in a humid state, not only because it will not adhere with certainty, but because it encloses and shuts in the moisture. The detrimental effects of humidity not only apply to wood work, but tend to bricks, stones, and all things that are absorbent, especially if they are at all soluble at the same time; but the worst consequences ensue from the exercise of frost upon bodies that contain moisture; for water in freezing crystallizes, and occupies more bulk than in the fluid state; and the force with which the expansion takes place, is so great, as to be capable of bursting the strongest water-pipes, lifting portions of walls, and disturbing the state and condition of the heaviest bodies. If, therefore, brickwork, masonry, earthwork, or even timber that is absorbent, happens to be attacked by frost while full of humidity, it is frequently so burst or shaken by its effects, that if it does not fail immediately, it becomes so loosened and detached as to give way afterwards to the smallest force, or at any rate its surface becomes more disposed to rapid decay. Many varieties of brick and stone, that is, such as absorb moisture readily, and are tardy in parting with it again, ought therefore never to be selected for outside or foundation work. The same reasoning explains why external brickwork and masonry, as well as plastering, should not be done in frosty weather; for if the water necessarily introduced into the mortar should freeze before the mortar sets, it will afterwards fall to powder, and never make a strong or adhesive joint. Nothing resists the effects of spontaneous decay more effectually than charcoal, and it is on this account that the bottoms of wooden posts are frequently burnt before inserting them in the ground. The error generally committed is in not burning the surface of the wood to a sufficient depth; because when advantage is to be taken of the preservative quality of charcoal, it ought to have a considerable thickness. The salt of mercury, called corrosive sublimate, has a wonderful power in resisting decay, as well as in preventing the occurrence of dry rot, one of the greatest enemies the builder in wood has to contend with. See the article Dry Rot.

The effects of wind can only be guarded against by strength, and the adoption of such forms as will not present flat sides for the wind to act upon. On this account the round or cylindrical shaft of a column, will have a much better chance of standing against a high wind than a square shaft or chimney exposing the same surface; because in whatever direction the wind comes against a cylinder, it is always met by a round surface which divides it, and presents an oblique action. Had the shaft been square, and the wind blowing perpendicular to any one of its sides, its power would be much greater, although it would be still further diminished when blowing against one of its angles. On this account the spires of churches are never made in the form of square pyramids, but are polygonal, but would be stronger, though less handsome, if round. Light-houses for navigation, where strength is more important than beauty, are made circular and tapering towards the top. The effects of wind ought always to be guarded against in every erection, with the same care as weight or any other force; for if this is not attended to, the whole may be unexpectedly destroyed. One of the chief objects of bracing in carpenter's work, is to resist the action of wind.

Electricity has a double action, sometimes showing itself in the powerful and tremendous form of lightning; and constantly operating to produce the decomposition and decay of things by the slow and unperceived influence of galvanic action. Lightning can only be guarded against by the erection of proper conducting rods. See article Conductor.

It has long been known, that where wrought iron railing or other work was fixed to stonework, by letting the iron into the stone, and filling up the vacuity with melted lead, the iron would decay much more rapidly in the open air near the lead than in any other part. Likewise that ships fastened together by iron bolts could not be sheathed with copper, on account of the rapid decay of such bolts; consequently, all vessels intended to be coppered, are fastened with copper bolts. No one suspected this to be an electrical effect, until the late researches into galvanism laid open the fact, that whenever two metals possessing different susceptibilities of oxidation, were placed in contact with each other, and with water or any saline solution at the same time, the most oxidable metal would soon be dissolved and disappear. Iron is painted with oil paint, to preserve it from the effects of weather, and the base or body of such paint is usually white lead, or carbonate of protoxide of lead reduced to powder and ground with linseed oil. Recent experiments that have been made, seem to prove that even the oxide of one metal is not a proper protecting cover for another, on account of a galvanic decomposition, similar to that above referred to, being brought about; and that the earths, such as the ochres and boles, sulphate of baryta, and animal charcoal or ivory black, are much better calculated for insuring duration. Asphaltum, which is a black and very insoluble bituminous substance, also makes a good and permanent covering for iron in the nature of a japan or varnish, as it dries with a fine gloss.

As the great enemy to the durability of materials is humidity, and their being permitted to be occasionally wet and dry, so of course every thing that tends to prevent this effect taking place will promote durability. For this reason all wood and iron or other metal work, especially such as is exposed to the constant action of the atmosphere, should be thickly painted with oil colour, or should be covered with pitch, tar, or something that is capable of resisting atmospheric action. All roofs and walls should be made as smooth as possible, and all projections and cavities that may catch and retain water, should be avoided. Although pointing a wall, which is scraping out the old mortar from its joints, after it begins to decay, and filling the cavities afterwards with new mortar that will become hard, adds but little to the strength of a wall, yet it adds much to its duration. For old and decayed mortar is porous and so absorbent, that it retains humidity a long time, and the exposed upper edges of bricks and stones catch and retain water, which soaks into the wall, and the use of pointing is to fill up all these cavities, and produce a uniformly smooth surface, upon which water will run down. For the same reason all large timbers exposed to the open air, should have their upper sides worked into a *saddle-back form*, that is, should be angular upwards like a roof, to such an extent as will prevent water lodging upon them, as it would do if the upper side was a horizontal plane.—*Millington.*

DURAMEN. The heartwood of exogenous shrubs and trees. The alburnum of each succeeding year becomes the duramen of the next; and the aggregate duramen constitutes timber. The duramen of most trees is white; that of fancy-woods is of very various and diversified colours; that of oak is deep brown: that of guiacum is deep green; and that of ebony is black. The duramen of different genera differs widely also in hardness, frangibility, chemical secretions, and other properties. See the articles ALBURNUM and TIMBER.

DURMAST. See OAK.

DUST-BRAND. See SMUT.

DUTCH ASHES. See ASHES.

DUTCH CLINKERS. Small and very hard paving bricks, made in Holland, and somewhat extensively imported into England. They are about the breadth and thickness of a man's hand; and are set lengthwise, upon a bed or floor of sand. They make excellent roadways in the streets and highways of Holland; and are admirably adapted to the paving of the yards and outhouses of the farmeries of such parts of England as are destitute of other good, cheap, paving materials.

DUTCH HOE. See HOE.

DUTCH PLOUGH. See PLOUGH.

DUTCH-RUSH. See HORSETAIL.

DYER'S-BROOM. See BROOM.

DYER'S GREENWEED. See GREENWEED.

DYER'S OAK. See QUERCITRON.

DYER'S ROCKET. See DYER'S WEED.

DYER'S WEED,—botanically *Reseda luteola.* A biennial, indigenous, agricultural plant, of the mignonette genus. It bears also the popular names of weld, wold, yellow weed, dyer's rocket, and little yellow dyer's weed. It grows wild on waste grounds, and particularly among the rubbish of quarries and coal-pits, in various districts of Britain; and it is cultivated in the vicinity of manufacturing towns, to the full extent of the demand for it on the part of dyers. Its stems are erect, from two to five feet high, and ramify, toward the top, into several upright branches; its leaves are spear-shaped and entire; and its flowers are produced in long, terminal, greenish-yellow spikes, and naturally bloom in June and July.

As an agricultural plant, it gives comparatively little trouble, and seems to be eminently remunerating,—for when once cultivated by farmers, it seems to be, in every case, a constant favourite with them as long as they can find a market for it; but it is necessarily in very limited demand, and is even less so at present than it was at a former period. It flourishes on almost any kind of soil, but is most luxuriant upon a good loam, or upon argillaceous sand. It is sown in August, either broadcast and very lightly harrowed, or in drills and very slightly covered; or it may be sown in spring, in broadcast intermixture with some other crop which requires very light harrowing. The proper quantity of seed for broadcast sowing by itself is about twelve pounds per acre. The soil must be in a state of the most thorough tilth, perfectly powdery, and somewhat dry. The young plants must be kept free from weeds; and the maturing plants must be pulled either when expanding their flowers or just before they form their seed; for if allowed to seed, they both lose some of their value for the dyer, and act exhaustingly upon the soil. They are pulled up by the roots, set in small gatherings to dry, bound into sheaves, and built into stacks; and they neither incur any risk of heating in the stack-yard, nor lose any of their virtue when kept there through a series of years. The grand objection to the cultivation of this crop is the risk of not finding a purchaser; and this is, in some degree, obviated, though far from being wholly so, by the capacity which it has of being kept for so long a time uninjured.

Dyer's weed may be used by the dyer either green or dry; the whole plant is useful to him; and it requires no other treatment than to be enclosed in a linen bag, and boiled among the water in which the articles to be dyed are dipped. The colour which it yields is yellow; but it is in itself exceedingly fugitive, and requires to be fixed with some such mordant as about a quarter of a pound of alum and one or two ounces of tartar to every four or six pounds of the dried plant.

DYE-PLANTS. Plants which are used in the art of dyeing, or which give out their colouring matter to woven fabrics. Hardy dye-plants, or such as could be freely cultivated on the open ground in Britain, are very numerous; but, in consequence partly of the very inferior character of some, and partly of the cheap rate at which vegetable dyes can be obtained from foreign countries, very few are in actual cultivation. The chief of those which challenge the economical cultivator's notice are dyer's wood, *Isatis tinctoria;* dyer's weed, *Reseda luteola;* dyer's madder, *Rubia tinctoria;* common yellow-flowered bedstraw, *Galium verum;* dyer's woodroff, *Asperula tinctoria;* dyer's safflower or bastard saffron, *Carthamus tinctorius;* and common saffron, *Crocus sa-*

tinus. Among other hardy herbaceous dye-plants, exotic and indigenous, and more or less notable, are numerous other species of madders and bedstraws; the Siberian wild rue, *Peganum harmala;* the Spanish gold thistle, *Scolymus Hispanicus;* dyer's coreopsis, *Coreopsis tinctoria;* dyer's chamomile, *Anthemis tinctoria;* narrow-leaved hawkweed, *Hieracium umbellatum;* trifid bidens, *Bidens tripartita;* small burdock, *Xanthium strumarium;* common sorrel, *Rumex acetosa;* the common round-leaved bellflower, or harebell, *Campanula rotundifolia;* the red-rooted beet, *Beta vulgaris;* common agrimony, *Agrimonia eupatoria;* common loosestrife, *Lysimachia vulgaris;* meadow rue, *Thalictrum flavum;* kidney vetch, *Anthillus vulneraria;* common branching larkspur, *Delphinium consolida;* rye-like brome-grass, *Bromus seculinus;* the common nettle, *Urtica dioica;* the wood hedge nettle, *Stachys sylvaticus;* spotted asmart or bistort, *Polygonum persicaria;* devil's bit, *Succisa pratensis;* water horehound, *Lycopus europæus;* cow-weed, *Cherophyllum sylvestre;* the common reed, *Phragmitis communis;* Virginian pokeweed, *Phytolacca decandria;* dyer's saw-wort, *Serratula tinctoria;* common ragweed, *Senecio jacobæa;* upright tormentil, *Tormentilla erecta;* common marjorum, *Origanum vulgare;* and marsh cinquefoil, *Comarum palustre.* The principal cultivated trees and shrubs of our climate whose wood, bark, leaves, or fruit yield dyes, are the common sumach, *Rhus coriaria;* the dyer's oak, *Quercus tinctoria;* the staining oak, *Quercus infectoria;* dyer's broom, *Genista tinctoria;* alder buckthorn, *Rhamnus frangula;* common purging buckthorn, *Rhamnus catharticus;* common oak, *Quercus robur;* common ash, *Fraxinus excelsior;* common plum, *Prunus domestica;* common birch, *Betula alba;* candleberry myrtle, *Myrica gale;* common apple-tree, *Pyrus malus;* common hornbeam, *Carpinus betulus;* common barberry, *Berberis vulgaris;* common walnut, *Juglans regia;* blaeberry or myrtle bilberry, *Vaccinium myrtillus;* and sweet willow, *Salix pentandria.* The principal plants of foreign growth, whose wood or preparations of some parts of which are imported to Britain as dye-stuffs, are logwood, *Hæmatoxylon campechianum;* saunders' wood, *Plerocarpus santilinus;* sappan red wood, *Cæsalpinia sappan;* arnatta, *Bixa orellana;* turmeric, *Curcuma longa;* Brazil wood, *Cæsalpinia brasiliensis, C. echinata*, and *C. crista;* indigo, *Indigofera tinctoria, I. anil*, and *I. argentea;* ebony, *Diospyros ebenum* and *D. ebenaster;* and fustic, *Maclura tinctoria.* Many cryptogams, particularly among the lichens and the algæ, yield dyes; but the chief are cubbear, *Lecanora tartarea*, and orchel or archel, *Rocella tinctoria.*

The vegetable dyes, either as they naturally exist in the plants, or as they are obtained for practical application, are usually in combination with farinaceous, mucilaginous, resinous, extractive, or other proximate principles; and are much affected or even controlled by them in their mechanical conditions and in their capabilities of solution. All change their tints, and enter into new combinations, under the action of acids and alkalies; most are decomposable under the combined action of light and moisture; many are exceedingly fugitive as dyes, unless made "fast" by the action of substances which change their chemical relations without changing their colours, and which therefore are called mordants; and all, without even one known exception, are destroyed, or "bleached" into utter dissipation, by the action of chlorine. The principal colours are red, yellow, and blue; and all others may be produced by mixtures of these,—for example, green by the mixture of blue and yellow, violet by the mixture of red and blue, and orange by the mixture of yellow and red.

DYKE. See DIKE.

DYNAMIC AND ATOMIC THEORIES. The names given to two celebrated systems, explanatory of the essential constitution of matter. In the dynamic theory, every body is considered as a space filled with continuous matter; porosity then becomes an accidental quality, but compressibility and dilatability essential properties. The state of a body depends entirely on certain attracting and repelling forces; and its volume must change with every change in the relative proportions of these forces. All the varieties of matter are explained by supposing the existence of certain primitive simple substances, the different combinations of which produce all bodies. When two substances combine chemically, they must be considered, on this system, to penetrate each other mutually. The partisans of the atomic theory suppose every body to be composed of indivisible and impenetrable particles, which they term *atoms.* These are almost infinitely small, with void spaces between them, so that this theory makes porosity essential to matter. The atoms are not in contact, but are kept in their relative positions, at certain distances, by certain attractive and repulsive forces; from whence it arises, that, in the volume of each body, there is much more void space than matter. On this system, the diversities in bodies may be explained, either by an essential difference in the atoms themselves, or by a difference in their form, size, position, and distance. When two substances combine chemically, the atoms of one penetrate the interstices of the other, and the atoms of the two combine so intimately, that they become, in a manner, new sorts of constituent particles, excepting that they are not simple, but compound.

DYSENTERY. An inflammatory, purging, contagious, and violent disease in the bowels of animals. It is very liable to be mistaken by ignorant or superficial observers for the far milder disease of diarrhœa; but it is readily distinguishable from that disease as to both its nature and its symptoms; and as it is vastly more violent and frequently fatal, it ought to be easily recognised by every man who has charge of any of the animals of a farm. See the article DIARRHŒA.

Dysentery in the horse occurs oftener in young animals than in old ones, and in robust than in feeble ones; and is most frequently occasioned by a sudden check to perspiration, a sudden and injudicious change of food, much exposure to cold and fatigue, browsing on the herbage of marshes, the taking up of mineral poisons in food or drink, and the excessive use of purgative or drastic medicines. It sometimes begins in diarrhœa, but is more commonly an independent or primary disease. It consists in inflammation of the mucous membrane of the large intestines, attended with an increase and a morbid alteration of the mucous secretions, and with a general inflammatory and febrile action. The fæcal discharges from it are frequent, slimy, fetid, and of unctuous appearance, so as to have caused the disease to be called among farriers of the old school "molten grease;" and when the disease becomes exceedingly virulent, and aggravates itself into ulceration of the intestines, these discharges contain blood and leathery-looking pieces of coagulated lymph. The affected animal has dry mouth, heaving flanks, hot ears, great thirst, no appetite, much pain, and constant irritation and restiveness of the rectum. The veterinary surgeon, except in the most ordinary cases, ought to be consulted; and if he be a skilful man, he will bleed the animal, and probably administer castor oil and opium,—and, if the case be attended with violent inflammation, as indicated by the very corded or perhaps wiry condition of the pulse,—he will either apply a mustard poultice or order an opiate fomentation.

Dysentery in cattle is sometimes epizootic, sometimes the consequence of other diseases in individual animals, and sometimes, what glanders and farcy are in horses, the breaking up of the constitution; and, regarded in the aggregate as a scourge of flocks of the domestic ox, it is not of very frequent occurrence, and yet, in some instances, sweeps away cattle from districts by the thousand. In its ordinary forms, it shares with diarrhœa the popular names of scouring and scouring-cow, and takes to itself the additional popular names of braxy, bloody ray, and slimy flux; and in its most virulent forms, particularly when occasioned by the general breaking up of the constitution, it is known to many farmers under the indefinite and incorrect yet very expressive name of rottenness. When coming down upon herds as an epizootic, it is, in general, curable only in the mildest cases, and almost uniformly fatal in smart or violent cases; yet may usually be averted by the cheap and easy precaution of administering an aperient to each individual of the unattacked. A description of its symptoms during a particular one of its epizootic ravages, may serve as a general indication of its epizootic character. "The disease was ushered in by a dull anxious appearance; the eye-lids and dewlap were of a yellow tinge, and in dairy cows there was a total suspension of the secretion of milk; a slight muco-purulent discharge from the nostrils was also observed; the appetite was indifferent, bowels costive, the dung of a dark colour, having portions of blood diffused through it; but the urine was not much affected. The pulse for the first 24 or 40 hours, when the disease came on more gradually, was not much affected; but afterwards it became frequent, small, and hard, beating at the rate of 70 or 80 pulsations per minute. In extreme cases, the febrile action set in from the first, accompanied with violent diarrhœa and tenesmus, the fæcal discharge being intolerably offensive, and consisting of a thin, watery, dirty, green-coloured fluid, full of shreds of coagulable lymph, mucus, and grumous blood. In some, it consisted of a blackish green mucous discharge; in others, it was principally mucus, coagulable lymph, and blood, with, comparatively speaking, no portion of fæces along with it. The extremities were alternately hot and cold: the surface of the nose sometimes dry, at others having a dew upon it. Occasionally during the cold fit, the eyes would become sunk in their orbits, the features collapsed; the nose, inner part of the lips, and tongue were of a deadly pallidness, which would be followed up by reaction, and a consequent hot fit again. The bowels were affected, in some of the extreme cases, with colicky pains; and in every case, there was obstinate constipation and obstruction in the second and third stomachs. If relief was not afforded, the disease terminated fatally on the third or fourth day." In ordinary cases of dysentery, the fæcal discharge affords a ready indication of the disease being quite different from diarrhœa; for it is frothy, slimy, either brown or yellow, stringily and patchily mucous, exceedingly fetid, and very hot and reeking. In cases arising from general debility or from the breaking up of the constitution, the first outburst of the disease may subside, pain may appear to wear away, and the principal remaining symptoms may be lassitude, want of appetite, rapid emaciation, frequent purging, and a peculiar and forcible manner of ejecting the fæces which is sometimes popularly called "shooting." The proper treatment of dysentery in cattle requires great skill and nicety; it is, in a considerable degree, a subject of dispute among eminent veterinarians; and, even when most judicious, prompt, and continued, it frequently proves unavailing. Its principal elements are bleeding, a gentle aperient, some form of opiates, and—according to the judgment of a portion of modern skilful farriers—mercurials, setons, fomentations, tonics, clysters, and very powerful astringents. But wise farmers, the moment they ascertain dysentery to appear among their cattle, will use all speed in obtaining the best professional advice within their reach. Cattle recovered from dysentery ought, till they regain strength, to be kept away from green food and from luxuriant pastures.

Dysentery in sheep sometimes results from diarrhœa, and is more frequently occasioned by great and sudden changes of food and situation. Many persons call it flux or scouring,—names which it is made to share with diarrhœa; and some absurdly call it braxy,—a name which properly belongs to a totally different and very virulent disease—inflammation of the abomasum. See the article Braxy. All shepherds ought to be able to distinguish readily and promptly between dysentery and diarrhœa; and they should feel bound to adopt speedy measures of protection and cure whenever a case of dysentery occurs. A sheep affected with dysentery is languid and yet restless, and very frequently lies down and rises. His mouth is hot, his nostrils are dry, his eye-lids are red, his breathing is quick, his pulse is wiry, and his fæces are frequent, scanty, hard, fetid, and accompanied with mucus and blood. The disease is sometimes speedily fatal; and sometimes it slowly but steadily protracts its action for weeks. In mild cases, mere astringents may effect a cure; in decidedly inflammatory cases, first a mild aperient and next an opiate or two are required; and in very bad and complicated cases, all appliances similar to those in the case of cattle may be needed, and may be far from proving uniformly effective. One very good astringent drink consists of 20 drops of laudanum, 20 grains of prepared chalk, two drachms of tincture of catechu, two drachms of tincture of cinnamon, and half a pint of warm oatmeal gruel. —*The Veterinarian.—Bartlet's Farriery.—Blaine's Veterinary Art.—Knowledge Society's Treatise on Cattle.—Spooner on the Diseases of Sheep.—Clater's Cattle Doctor.—Cleeve's Prize Essay on the Diseases of Sheep in Journal of Royal Agricultural Society of England.—Mackenzie on the Diseases of Sheep. —Paper by Professor Dick in Quarterly Journal of Agriculture.*

DYSOPHYLLA. A genus of ornamental plants, of the lip-flowered order. The starry-species, *D. stellata*, was recently introduced to Britain from India, and is found growing wild in Malabar and Mysore. It is a very elegant and delicate plant, scarcely a foot high, and blooming in October. Its leaves are narrow, linear, and pointed, and grow in whorls of from 6 to 8 at short intervals upon the stem and branches; and its flowers are individually like the flowers of mint, but grow in long and crowded spikes in the same manner as those of the most conspicuous species of veronica.

E

EADDISH. See Aftergrass.

EAGLE,—scientifically *Aquila*. A genus of large and very noble birds of prey, forming the type of the aquiline division of the order Raptores. They are pre-eminent among birds of prey in at once size, strength, beauty, daring, longevity, and celebriousness. They have, in common with other genera of their order, a strong and hooked beak, sharp, incurved and powerful talons, three toes before and one behind, a rapid and soaring flight, and a bold, predatory, carnivorous disposition; and they possess, as characteristics of their own, large and perforated cere, rounded nostrils, sub-triangular beak, thoroughly plumed tarsi, and exceedingly ample and mighty wings. They repose in calm dignity on the beetling summits of alpine crags; they soar into the upper atmosphere, through showers of sunbeams, with a strength of eye and a power of wing peculiarly their own; and they swoop down from cloud or crag, upon a minute object of prey, with an accuracy of aim, a suddenness of descent, and a might of pinion which astonish and overawe even practised observers. They are popularly, and not with any exaggeration, regarded as the princehood, the royal family, of the feathered kingdom, maintaining similar superiority over birds to that which the lion possesses over the quadrupeds of the wilderness.

Of the various birds that inhabit this country, perhaps none have attracted more attention than the eagles, of which two species are indigenous. The Golden or Ring-tailed eagle, *Aquila chrysaetus*, although formerly not uncommon in various parts of Britain, is now chiefly met with in the mountainous districts of the middle and northern divisions of Scotland, and in the larger Hebrides, where the species still maintains a rather precarious existence. Excepting the White-tailed Sea eagle, *Haliaetus albicilla*, it is the largest of our rapacious birds. As is generally the case among the Raptores, the male is much inferior in size to the female. Several individuals were about two feet nine inches in length, their expanded wings measuring about six feet; the body robust; the neck of moderate length; the head rather large; the wings when closed reaching nearly to the end of the tail, which is rather long, broad, and rounded; the bill is rather short, very deep, compressed with a curved acute tip; and the feet, which are feathered to the lower tarsal joint, are very muscular; the toes strong, united at the base by a short web, and furnished with large, curved, tapering, acute claws, rounded on the sides, and flat beneath; those of the first and second toes being largest. The bill is greyish blue at the base, black at the end, as are the claws; the cere and toes yellow. The general colour of the plumage is dark brown; the hind head and neck light yellowish-brown; the inner and fore sides of the legs and tarsi reddish-brown. The quills are brownish-black, their inner webs irregularly barred with greyish-white; the tail brownish-black towards the end, its proximal part lighter, and irregularly barred or mottled with greyish. The female is generally about three feet two inches in length, with the extended wings measuring about seven feet; the weight varying from ten to twelve pounds. The colours are similar to those of the male, but generally lighter. Young birds have the basal portion of the tail white, that colour being gradually encroached upon by the brown, until the fifth or sixth year, when it entirely disappears.

This beautiful, powerful, and rapacious bird, having very frequently come under our observation both in the wild and captive states, we are enabled to present to our readers a somewhat detailed account of its habits. All eagles when at rest have a peculiarly clumsy appearance, owing chiefly to the great size of their wings, which they seem to find it difficult to dispose of in a neat and compact manner; but when roused they assume a bold and lively attitude, rendered more imposing by the glare of their full and bright eyes, which are partially overshadowed by the projecting lachrymal bones or eyebrows. The Golden eagle is more lively than the Sea eagle, and of more destructive habits; for, although a carrion bird, it frequently seizes grouse, hares, and other small animals, and sometimes attacks even deer and sheep. Great havoc is occasionally made by it among the lambs, before they have attained the age of six weeks; and in consequence of the injury thus inflicted, various methods have been employed for reducing its numbers. Sometimes its nest is assailed from above, by letting down a person upon a rope, who generally succeeds in destroying its contents, whether by removing them, or by lowering among them a bundle of combustible matter with a live coal enclosed. The old birds are shot, by being enticed, by means of a dead sheep or horse, to a spot in the immediate vicinity of which a person is concealed under ground, or in a small hut, so covered with heath that it cannot be distinguished from the surrounding surface. More commonly, however, eagles are trapped, at least on the mainland of Scotland.

The flight of the Golden eagle is very beautiful. Owing to the great size of its wings, it finds some difficulty in rising from the ground, although it is considerably more active in this respect than the White-tailed eagle; but when fairly on wing, it proceeds with great ease, and on occasion is capable of urging its speed so as to equal that of most large birds. However, even at its utmost stretch, it is certainly much inferior to that of the rock pigeon, the merlin, and many other species; and the raven, during the breeding season, finds no difficulty in overtaking an eagle that may happen to fly near his nest. When searching the hills for food it flies low, with a motion of the wings resembling that of the raven, but with occasional sailings and curves, in the manner of many hawks. At times it ascends high into the air, and floats in a circling course over the mountains, until it has discovered some large object; but in tracing grouse and other animals concealed among the herbage, or in hunting for sea-fowls and their young, it does not indulge in those aerial gyrations, which many closet and some field naturalists have supposed to be performed solely for the purpose of enabling it to spy out its prey from afar. In its ordinary flight, it draws its legs close to the body, contracts its neck, and advances by regular flappings of the wings; but when sailing, it extends these organs nearly to their full stretch, curving them at the same time a little upwards at the tips. An eagle sweeping past in this manner is a most imposing object, the more especially if in the vicinity of its rocky haunts, and still more if the observer be groping his way along the face of a crag, anxiously seeking a point or crevice on which to rest his foot.

Both our native eagles sometimes ascend to an immense height in fine weather, and float high over the mountain tops for hours together; but certainly not for the purpose of descrying the objects beneath, for no person has ever observed their sudden descent from this sublime station. It is a popular notion, countenanced even by many anatomists and others, who ought to know better, that the eagle mounts towards the sun in order to enjoy unrestrained the sight of that glorious luminary. They tell us that its eye is peculiarly fitted for this purpose by having a strong semi-opaque nictitant membrane, by means of which the rays are blunted; but they forget that the common duck, the domestic fowl, and the sparrow, which are not addicted to astronomical investigation, have eyes organized precisely in the same manner.

On the ground, the Golden eagle, like all others, is extremely awkward; for, owing to its large wings, its great weight, and the form of its toes, which are encumbered with very large curved and pointed claws, it can only walk in a very deliberate manner, or move from place to place by repeated leaps, in performing which it calls in the aid of its wings. Its feet in fact are not adapted for walking; they are most powerful organs of prehension, capable of inflicting mortal injury on any animal not exceeding a sheep in size. It is with them that it deprives its prey of life, and carries it off to its nest or to some convenient place of retreat. With its curved bill it tears off the feathers and hair; separates morsels of the flesh, and even crunches the bones of small animals. The male and the female keep together all the year round, and very probably remain attached for life; but should one of them be killed in the breeding season, the survivor is not long in repairing his loss. This circumstance is not peculiar to eagles, but has been frequently observed in other birds, more especially those of the crow family. The Golden eagle prepares its nest about the beginning of March, choosing a place for it as nearly inaccessible as possible. Although it is often met with on the maritime cliffs of the Hebrides, yet the species has a greater predilection for inland precipices than the Sea eagle. It is of great size, flat, and formed of sticks, twigs, grass, and other materials. The eggs are generally two, sometimes single, yellowish white, with irregular, pale, purplish dots. The young are fledged about the end of July, and soon after coming abroad, are left to shift for themselves, or are driven off from the haunts of their parents.

The cry of this species is clear and loud, and may be heard in calm weather to the distance of a mile. It resembles the syllable *cleek* or *queek*, several times repeated; but although in captivity the bird frequently utters it, in the wild state it is less loquacious. When kept a prisoner it is more ferocious than the Sea eagle, and can scarcely be trusted even by the person who supplies it with food. The capability of existing under long-continued privation has sometimes been exhibited in a wonderful degree by captive eagles, which have been accidentally neglected for days or even weeks.

Many marvellous tales are told of eagles, and there is scarcely a parish in Scotland, in which, if tradition be correct, they have not carried off a child. According to popular belief, an eagle transported one from the island of Harris to Skye, over a space of about twenty miles; but as even more wonderful events are as firmly believed, no confidence can be reposed in such accounts. Although individuals of the species sometimes appear in various parts of England, it is probable that they seldom or never breed in any district of that country. The species has been extirpated from the south of Scotland, as has very nearly been the case with the Sea eagle; and it is only in the central ranges of the Grampians, or in the wild glens of the northern division, and among the hills of Skye, Rum, Harris, and other islands on the north-west coast of Scotland, and in the western Irish Highlands, that the ornithologist has much chance of meeting with it.

EAGLE-WOOD. See ALOE-TREE.

EAR. An animal's organ of hearing. Its internal structure is somewhat similar in man and in the numerous species of the higher orders of quadrupeds; and it possesses, in all, a very complex and yet simple organization, exquisitely adapted to its functional uses, beautifully combining utility with protection, and admirably illustrating the wisdom and beneficence of the Creator. Its external structure, in the several animals, varies in adaptation to their respective habits and constitution; and affords, both in its general form and in its wide variations, high and striking evidences of minute and most benevolent design. Though any description of either the internal or the external structure would be out of our province; yet one great differential feature may be noticed,—that the outward ear of timid and graminivorous animals usually lies backward, to enable them to detect sounds of danger or pursuit, while that of predacious and carnivorous animals usually lies forward to enable them to catch early intelligence of prey.

The outward ear of the horse is a truncated, obliquely severed, and very elegant cone, so admirably constructed as to receive a vast volume of vibration in the air, and so exquisitely mounted on organic mechanism as to wheel and circle and oscillate with the utmost power and freedom of motion. The ears of a horse, especially of a spirited one, are in continual play, and are so often and easily stretched in directions opposite to each other as to serve the purpose of a double organ, and possess such power and play of nerve as to afford expressive indications of temper and intention. "The ears," remarks Mr. Blaine, "are usually supposed criterions of the spirit of the animal; and I have seldom seen a horse who carried one ear forward and the other backward during his exercise, especially if on a journey, but what was lasting and good. The reason appears a plain one: a horse of spirit, strong, and not easily fatigued, is attentive to everything around him, and directs one ear forward and one ear backward to collect sounds from every quarter. I need not mention that the ears are an indication of the temper of the animal, and that he is seldom either playful or vicious but the ears are laid flat on the neck. It was kind in Providence to give us such a warning in an animal who does not want craft to surprise us, nor strength to render his resentment terrible." The twitching of a horse's ears in the way of discipline or punishment may occasionally be necessary in a case of great obstinacy, and in order to prevent a severe application of the whip to other parts of the body; but generally it is both unnecessary and cruel, and sometimes it inflicts very painful wounds and contusions. When a wound in the ear is merely a laceration of the cartilage, it readily heals; but when it is an ulceration of the integument and the cellular substance, it will probably be healed by no gentler means than powerful caustics or the application of the cautery.

The ears of cattle have a very different form and size in some breeds than in others; and they constitute one of the minute or secondary points by which the character and the comparative value of breeds are judged. They are usually of well-proportioned size and freely moveable in the polled breeds; and are comparatively small, inconspicuous, and stiff in most of the horned breeds. But the ears of Suffolk cows and of Ayrshire cows are gaunt and deformingly large; and fully formed but especially very large ears are usually regarded as indications of coarseness of form; yet they possess the value of being excellent and adroitly-used means for the animals protecting their eyes. Contusions followed by swelling and abscess and sometimes by deafness, are not uncommon in the ears of cattle; and they ought to be reduced by means of such appliances as fomentations, anodyne lotions, and astringent washes. A dry scurf often forms on part of the inside of the ears, and occasions excessive and painful itch; and this may, in most instances, be speedily removed by means of a little calamine and rosin ointment. Small fungous growths appear, in some rare cases, at the base of the ear; and these must be removed first with the knife, and next with a strong caustic wash. Inflammation of the ear also occurs in rare cases, and must be reduced by bleeding, fomenting, and purging.

The ears of some breeds of swine are peculiarly and amazingly subject, in the back part of their great lops, to troublesome cracks and sores. A good cure in these cases, as in that of scurf in the ears of cattle, is calamine and rosin ointment. "If there is any disposition to mange in swine," remarks Mr. Clater, "it is most evident about the ears of these animals; and the mischief is sadly aggravated when brutes in human shape set every ferocious dog at the stray pig, the favourite hold of which is the ear."

EAR. A spike or head of oats, barley, wheat, or other cereal grass. Ears of corn, though an almost universal popular phrase, is a somewhat indefinite one, and cannot be used in botanical or minute description.

EAR-COCKLE, PURPLES, or PEPPERCORN. A disease in wheat, occasioned by the animalcule *Vibrio tritici.* Grains infected with it turn first dark green, and afterwards nearly black; they become rounded, and acquire a form and an appearance somewhat like those of small peppercorns, but with one or more deep furrows on their surface; and their husks are so spread open, and their awns so twisted, as to cause them to be readily observable among standing corn. A moist, white, cottony-looking substance is found, on inspection, to fill all their interior instead of flour; and this, if soaked with a drop of water, and placed under a microscope, will be seen to disport itself into a multitude of eel-shaped animalcules, twisting themselves and wriggling backward and forward in the manner of snakes. When the cottony mass of a quantity of wheat infected with ear-cockle is extracted in the process of grinding at the mill, it does not pass through the cloth with the fine flour in the beating, but remains with the bran. The animalcules of an ear-cockled grain which happens to be sown along with sound wheat remain in it till March; they then depart from it, travel through the soil to the adjacent wheat-plants, and begin gradually to ascend their stem till they reach their ovules or young flower-buds; and there they deposit a great number of eggs, and die and disappear. The young animalcules are hatched in the course of 8 or 10 days after the eggs are laid; and they speedily attain a length of about ·03 of an inch, and a diameter of about ·00083 of an inch, and in that state constitute the cottony-looking mass of the grains; but the full-grown animalcules — those which travel away from the seeds and propagate the species in spring—have an enormous size compared with the young, or with the tenants of the grains, and attain a length of about ·25 of an inch, and a diameter of about ·0125 of an inch. These animalcules belong to the tribe which possess the very remarkable capacity of reviving under moisture after lying for a long period in a dry and seemingly dead condition. "If a mass of them," says Professor Henslow, "is suffered to become so perfectly dry that the slight touch of a hair might reduce them to powder, and they are again moistened in a drop of water, they will speedily revive, and become as active as before. They may thus be dried and revived many times before they are killed. Mr. Bauer states the limit to such revivals to lie between six and seven years." See the articles ANGUILLÆ and ANIMALCULE. Ear-cockle is not a very common disease of wheat, and is totally unknown in some districts; yet it infests some places to such an extent as to have occasioned, in the last or sedimentary portions of wheat at the mill, so large a proportion of diseased grains as about half a peck in the bushel. The mere immersing of seed-corn in water will not detect and separate infected grains; nor can the application of heat for the killing of the animalcules be raised sufficiently high without involving some risk of destroying the vitality of the seeds. The chief effectual preventive of repetitions of the disease on farms where it has appeared, is to procure seed-corn from some district in which the disease does not exist.

EAR-MARK. A notching, clipping, slitting, or other artificial mark, made on the ears of cattle, sheep, dogs, or other tame animals, with the design of distinguishing them from other individuals or flocks of their own species.

EARNEST. Any portion of price or wages, paid or given as ratification of contract. The smallest portion, even a penny, is sufficient; but in order to its binding the seller or the hireling to the terms of the agreement, it must be expressly stated to be earnest.

EARNING. See Rennet and Cheese.

EARTH. The world which we inhabit; or all the solid portion of this world; or all the mineral part of its crust; or all mineral matter which is not rocky; or all diluvium and mineral alluvium; or land; or soil; or mould; or the white, powdery, and incombustible oxide of a metal. In the sense of either the whole world, or the solid portion of the world, it is distinguished as *the* Earth; in the sense of a white oxide, the word is chemically and scientifically accurate; in the sense of soil, it is popularly correct, but falls to be discussed in the article Soil; and in all the other senses, it is exceedingly indefinite, and ought to be completely superseded by strict and proper terms.

Earths, in the scientific and thoroughly correct signification, are of two classes, alkaline and pure, the former amounting to four and the latter to six. The alkaline earths are lime, magnesia, strontia, and barytes, or oxides of calcium, magnesium, strontium, and baritum. They resemble alkalies in neutralizing acids, and in exerting a strong alkaline reaction with test paper; and they resemble the pure earths in whiteness, powderiness, incombustibility, and some other properties. Barytes and strontia are, in a considerable degree, soluble in water; and barytes, strontia, and lime are, in a powerful degree, caustic. The pure earths are alumina, silica, yttria, zirconia, thorina, and glucina, or oxides of aluminum, silicium, yttrium, zirconium, thorinum, and glucinium. Silica behaves, in a considerable degree, like an acid,—and its basis, silicium, possesses far more resemblance to carbon and boron than to the metals; and the other five, though combining in a degree with acids, are far less salifiable than the alkaline earths, and do not exhibit alkalinity with turmeric or litmus paper. All the six are white, and have a thoroughly mineral appearance, and, in their ordinary condition, are totally insoluble in water.

The most abundant of the earths are alumina and silica,—the former the characteristic principle of clay, and the latter the characteristic principle of flint, quartz, and quartzose sand; the earths next in abundance are lime and magnesia; and these four earths, in various combinations with one another, with water, with salts, and with other substances, constitute the grand bulk of the rocks, gravels, clays, and other solid parts of the crust of the world. Yet though the enormously major portion of the strictly mineral substances of the world consists of these four earths, the skin or superficial stratum which constitutes soil always comprises more or less of organic remains, or consists, in a considerable degree, of the decomposed and decomposing vegetable matters which are technically called humus or geine. See the articles Silica, Alumina, Lime, Magnesia, Soil, and Humus.

The four principal earths, and occasionally a minute portion of barytes, are taken up from the soil and secreted by plants, and may readily be separated from the organisms by incineration. Lime, chiefly in the form of phosphate, and partly in the forms of carbonate and sulphate, is comparatively abundant in very many plants, particularly in their roots, shoots, and seeds, and constitutes a principal portion of their incombustible matter obtainable in the form of ashes. Silica, in a vitreously saline combination with potash, constitutes the hard, smooth, and shining skin of the grasses and the equisetaceæ; and is the powerfully resistive principle which renders some of these plants, such as the Dutch rush, *Equisetum hyemale*, so well adapted for polishing brass and other alloys and metals. Magnesia occurs abundantly in some of the goosefoots, somewhat frequently in several of the fuci, and occasionally but sparingly in some other plants. Alumina occurs in very minute quantity in the bulbs of garlic, the leaves of the olive, and the root of some of the mallows.

Earth, in the sense of soil, but with special reference to its aluminous constituent, appears to be an essential element, if not to the nutrition of cattle, at least to their digestion. "If cattle are observed while they are grazing," remarks Youatt, "it will be seen that many a root mingles with the blades of grass; and these roots have sometimes no inconsiderable quantity of earth about them. The beast, however, seems not to regard this; he eats on, dirt and all, until his paunch is filled. It was designed that this earth should be gathered and swallowed. A portion of absorbent earth is found in every soil, sufficient not only to prevent the evil that would result from occasional decomposition" of herbage in the first stomach or paunch or rumen of a ruminating animal, "by neutralizing the acid principle as rapidly as it is evolved; but, perhaps, by its presence preventing that decomposition from taking place. Hence the eagerness which stall-fed cattle, who have not the opportunity of plucking up the roots of grass, evince for mould. It is seldom that a cow will pass a newly-raised mole-hill without nuzzling into it, and devouring a considerable portion of it. This is particularly the case when there is any degree of indigestion. The mould here is comminuted to the greatest degree, and probably possesses peculiar freshness." Kids, reindeer, and wolves also eat clayey soil,—and eat it in much larger proportional quantity than cattle do; human beings, in various parts of South America, of Western Africa, and of the Indian archipelago, eat clay as part of their constant aliment,—some of them to the enormous amount of upwards of 8 or 10 ounces a-day; and some diseased individuals of our own population possess an invincible appetite for either argillaceous or calcareous earth. Farmers ought to use care that all their stall-fed cattle be daily supplied with a small quantity of fresh and very fine rich loamy soil, or of richly pulverulent clay.

EARTH-BOARD. The mould-board of a plough, or part which turns over the soil. See the article PLOUGH.

EARTH-BUILDINGS. Walls or houses formed of compressed soil or clay. They are not uncommon in Normandy and the south of France; and, in order to obtain additional strength and durability, some of them are constructed with alternate boards of wood and layers of soil. Turf cabins, which abound in Ireland, and clay cottages, which sometimes occur in Britain, and also mud walls and turf fences, are varieties of earth-buildings; but all are so rude and obvious in structure as not to require any description.

EARTH-HACK. A hand implement, resembling a large hoe. It is used, sometimes as either a hoe or a cleaning scraper, but more generally and properly as a drag for pulling mineral manures out of a cart, in the same manner in which the dung-drag is used for farm-yard manure.

EARTHING, or EARTHING-UP. The heaping of soil upon the lower part of the stems of standing and growing plants, with the design of blanching them, of supporting them, of promoting the circulation of air and moisture around them, of draining away superabundance of rain, or of affording free scope for the increase of roots and for imbibition of food through the spongioles. The designs of blanching and supporting occur only in the garden, and are thoroughly proper in the case of all the plants to which they usually apply; but the other designs occur in both the garden and the field, and are in most cases either mischievous or doubtful. The main advantage sought to be attained by earthing is the affording to the roots of plants an ample bed of fine pulverized mould, both for their own growth and for the conveyance to them of their proper food; but this ought, in nearly all cases except that of the potato, and even to a chief degree in the case of the potato itself, to be provided for by proper draining and thorough tillage. Earthing does not, in even the most remote manner, correspond to any process or circumstance in natural vegetation; and, but for our being accustomed to it, would appear at a glance to be an artificial and a violent supplementary remedy for some great defect in the mechanical conditions of the soil.

The earthing of drilled corn is manifestly injurious. When a crop of corn receives its last dressing, its culms are usually from three to five feet high, and its roots, unless already shortened by the plough or the hoe, are even longer than the culms, and spread athwart the whole of the ground; so that, if the drills be four feet apart, the roots of the plants of each drill take up their food, on the average, over a breadth of four feet. Now when a plough is driven between the drills, a total disruption of one-fourth of this breadth of four feet is effected, one-fourth of the feeding or pasturing area of the plants is practically swept away, one-fourth of the spongioles or feeding-orifices and of the connecting radical fibres of the plants are destroyed, and a considerable proportion of the remaining spongioles and radical fibres are injuriously exposed to the effects of drought and of ardent sunshine. These surely are evils of vastly too great magnitude to be counterbalanced, far less compensated, by any possible advantages which earthing can be alleged to produce.

The earthing of turnips, though hitherto regarded by most cultivators with much favour, is probably quite as mischievous as the earthing of corn. Innumerable minute radical fibres grow out horizontally from turnip plants, and spread themselves athwart the whole of the usual interval between drills, and, on rare occasions, on particular mornings of summer, are visible to the naked eye in consequence of depositions upon them of dew somewhat similar in appearance to hoar-frost; and these fibres, even in connexion with their being so minute and so multitudinous, unquestionably take up a main part of all the finer nourishment for the feeding of the plants; and, in the process of earthing up, a large proportion of them are destroyed, and of course a corresponding proportion of the food of the turnips cut off. The injury often inflicted, to a considerable extent, upon the leaves of the plants also averts a considerable portion of the nourishment from the atmospheric gases, and makes a serious deduction from the attainable bulk of the crop. The mere hollow between the drills, too, acts as a channel for surface water to carry away some of the most enriching portions of the soil; the exhuming and exposure of a considerable part of the manure, occasions the loss of much of it partly by the sweep and drainage of the surface water, and partly by oxygenizement and gaseous escape into the atmosphere; and the unevenness or ribbedness of the ground, during the whole period of the folding of sheep upon the crop, prevents the soil from attaining as large an amount of enrichment as would accrue to it if its surface were level and smooth.

Even the earthing of potato crops, though to a certain extent useful, ought to be greatly modified by the conditions of the soil, and, as usually practised, is, in not a small proportion of cases, productive of far more evil than good. Two sets of roots exist in potato plants, and perform two widely different kinds of functions; the one proper or plant-feeding roots, growing as soon as the seed germinates, and shooting perpendicularly or obliquely into the soil; the other stoloniferous or tuber-bearing radicles, beginning to grow only after the plant is well or almost fully developed, and shooting in horizontal or lateral directions through the soil. Now the earthing of potato plants, when judiciously performed, makes no interference with the plant-feeding roots, but acts solely and most beneficially upon the stoloniferous radicles, increasing their width of range, multiplying their power of forming tubers, supplying them with food for nourishing up their tubers to a comparatively great size, and protecting the tubers themselves from the discolouring and powerfully deteriorating effects of exposure to the weather.

But the earthing of many kinds of potato land, particularly of porous and well-drained land, to a greater depth than two or three inches, and especially to a depth below the level of the plant-roots and the manure, occasions a serious waste of manurial nourishment, draws off an enormous proportion of the requisite aqueous nourishment, sometimes acts unfavourably upon the mechanical support obtained by the plants from the soil, and has been proved by experiment to subtract, in some instances, the enormous proportion of one-third from the aggregate value of the crop. "The deepness of the earthing below the dung and the roots," remarks Mr. Mackenzie of Stirling, "allows the moisture to drain from both; and if the potatoes are earthed up when the soil is moist, which is no uncommon case, the sides of the drills become smooth, and often harden in such a manner as to have some resemblance to baked clay, so that when rain falls, it runs down the sides of the drills as if tiles had been laid to carry it off. Then the nourishment which the fructifying showers bring to the soil for the benefit of vegetation, is, in a great measure, lost upon the potato crop. Such a mode of culture prevents the earth from drinking in 'the rain that comes oft upon it, that it may bring forth herbs meet for them by whom it is dressed.' Persons may satisfy themselves upon some of these points, by going to a potato field which has been treated in the manner above described, with a potato fork over their shoulder; and let them go after copious showers have fallen, and they will probably find the soil where the roots of the plants are as dry as dust,—many of the spongelets shrunk and unable to perform their functions, when the well-being of vegetation depends in a great measure upon their preservation; the dung, instead of being finely incorporated with the soil, will have some resemblance to gramineous peat, and might be employed as fuel to boil the potatoes instead of food to nourish them. In such circumstances, the potatoes will, in general, be a deficient crop; their character will be dry, small, and scabbed."—*Buel's Farmer's Instructor.—Stephens' Book of the Farm.—Paper by Mr. Mackenzie in No.* 59 *of the Quarterly Journal of Agriculture.*

EARTH-NUT,—botanically *Bunium*. A small genus of hardy tuberous-rooted plants, of the umbelliferous family. The greater, flexuous, globular-rooted, kipper, or pignut species, *Bunium flexuosum*, called by the older botanists *Bunium bulbocastanum*, is a well-known weed of sandy and gravelly pastures and woods in many parts of Britain. Its tubers are nearly globular, externally black, internally white, with a sweet, mucilaginous, aromatic, somewhat acrimonious, and decidedly agreeable flavour; its stem is striated, solid, from 9 to 24 inches in height, and branched towards the top; its radical leaves are twice or thrice pinnated, and very finely cut, and lie near the ground; its stem leaves are long, narrow, and acute, and occur singly below the ramifying points of the branches; its flowers grow in umbels like those of many other plants of the same family, and have a pure white colour, and bloom in May and June; and its seeds are small, oblong, and channelled. The tubers lie deep, and put out fibres from their bottom and sides; they are greedily dug for and voraciously eaten, by hogs and by country children; they have a taste and flavour scarcely inferior to chestnuts, and formerly took thence the specific name of bulbocastanum, or chestnut-tuber; they are quite delicious, as well as seemingly very nutritious, either raw, roasted, or boiled; and, if produced in plenty and perhaps somewhat enriched in flavour by cultivation, they might probably command an extensive and ready sale as an article of dessert. What a pity that such good things should be abandoned to the hogs, and degraded with the name of pig-nuts! Three species have, within the last 30 years, been introduced from the Spanish peninsula; and one of these has taken entirely to itself the old epithet of bulbocastanum.

EARTH-NUT (AMERICAN). See ARACHIS.

EARTHWORM,—scientifically *Lumbricus*. A genus of red-blooded worms, of the annelidous class of articulated animals. They are the common red worms of every ordinary soil, turned into view at almost every operation of the spade or the plough, and familiar to even the youngest and most careless observers; they possess the semi-cartilaginous annulations, the connecting longitudinal and oblique muscles, the double system of veins and arteries, and the moist enveloping, segment-showing skin which are common to all the red-blooded worms; they are devoid of branchial tufts, and possess a series of minute pores leading to very fine sacculi along each side of the body, in common with all the abranchiate division of their class; and they are armed with minute hairs or bristles, in common with the nais and the hairworm. Their eggs are somewhat oval, and about three lines long; they have at each end a kind of lid which opens to permit the exit of the matured wormlings; and each contains two yolks, and gives origin to two animals. Earthworms are hermaphrodites, and exceedingly prolific. They abound in all rich soils; and are always in a highly active state in spring; yet, as may be proved to any person who will take the trouble of examining a grass plot with the light of a candle, they come to the surface and move about in every mild night of winter.

Earthworms are generally regarded by farmers and gardeners as mischievous to their crops; but were their true character and economy fully known, they would be universally recognised as enrichers of the soil, and important ancillaries to cultivation. "Lands that are subject to frequent inundations," says White, in his Natural History of Selborne, "are always poor; and probably the reason may be, because the worms are drowned. The most insignificant insects and reptiles are of much more consequence, and have much more influence in the economy of nature, than the incurious are aware of, and are mighty in their effect. From their minuteness, which renders them less an object of attention, and from their numbers and fecundity, earthworms, though in appearance a small and despicable link in the chain of nature, yet, if lost, would make a lamentable chasm. For to say nothing of half the birds, and some quadrupeds, which are almost entirely supported by them, worms seem to be great promoters of vegetation, which would proceed but lamely without them, by boring, perforating, and loosening the soil, and rendering it pervious to rains and the fibres of plants, by drawing straws and stalks of leaves and twigs into it, and, most of all, by throwing up such infinite numbers of lumps of earth, called worm-casts, which, being their excrement, is a fine manure for grain and grass. Worms probably provide new soil for hills and slopes, where the rain washes the earth away; and they affect slopes probably to avoid being flooded. Gardeners and farmers express their detestation of worms,—the former, because they render their walks unsightly, and make them much work,—and the latter, because, as they think, worms eat their green corn. But these men would find that the earth without worms would soon become cold, hard-bound, and void of fermentation, and consequently sterile. And besides, in favour of worms, it should be hinted, that green corn, plants, and flowers are not so much injured by them as by many species of coleoptera (scarabs) and tipulæ (long-legs) in their larva or grub state,—and by unnoticed myriads of small shell-less snails, called slugs, which silently and imperceptibly make amazing havoc in the field and garden."

A piece of arable land on the sea-board of Lincolnshire lost its fertility in consequence of the destruction of all its earthworms by the breaking in of the sea, and regained its fertility in consequence of becoming again overrun with earthworms after the effects of the sea-burst had ceased. "Mr. Henry Handley," says Mr. Parkes, "showed me a piece of pasture land near to his house, in which worms were in such numbers that he thought their casts interfered too much with its produce, which induced him to have the field rolled at night in order to destroy the worms. The result was that the fertility of the field greatly declined, nor was it restored until they had recruited their numbers, which was aided by collecting and transplanting multitudes of worms from other fields." Earthworms act also as important auxiliaries to the drainer in all fine alluviums, rich loams, and pulverulent clays; and even when killed by the letting in of the tide in the English processes of warping, they leave valuable advantages behind them, and are soon succeeded by another race. "Their death no doubt occurs when the process of warping terminates, and the soil solidifies, but their holes remain entire and open from the top to the bottom of the mass, serving to admit air and moisture, and to pass the water of rain in finely divided streamlets to the drains; and the earthworm finally establishes himself in a soil easily penetrated and most congenial to his mining habits."

Earthworms then ought to be rather cherished than destroyed; yet when they are resolutely hated by either the prejudiced or the fastidious,—when they either continue to be regarded as foes to his crops by the farmer, or are disliked as deformers of his lawns and walks and tidy plots by the gardener,—they may be killed by a broadcast sowing of common salt, at the rate of 5 or 6 bushels per acre, or by a sprinkling of strong lime water, or by a sprinkling of a decoction of wood-ashes or of walnut leaves.

EARTHY MANURES. See Lime, Chalk, Ashes, Compost, and Sand.

EARWIG. An insect whose name is derived from its supposed habit of insinuating itself into the ears of persons who incautiously sleep among grass where it is found. It is extremely doubtful whether the animal intentionally enters the ear; and, indeed, there is no reason whatever that it should, except from mere accident. A piece of an apple applied to the orifice, is said to entice the insect, and thus relieve the sufferer; where this fails, a few drops of sweet oil destroy the life of the earwig, which must then be extracted with a proper instrument by a physician. A remarkable fact, in relation to the earwig, is its great abundance at particular times, and its subsequent rarity. From the observations of entomologists, it has been proved that these insects migrate in considerable flocks, selecting the evening for their excursions. Much damage is sustained by gardeners from the depredations of these little animals among fruit and tender vegetables, which constitute their proper food; occasionally, however, they feed on animal substances, and even devour each other. The places in which the species of this small genus are found are chiefly damp and cool situations, under stones and the bark of trees, among chests and boxes which have been long undisturbed, and in similar haunts. In the systems, the family which is formed of the original genus *forficula* of Linnæus, consists of two genera, *forficula* and *labidura;* to which another is added by Leach, the characters of which differ in so trifling a degree from the preceding, as to prevent its being generally received as distinct. It is even doubtful whether the simple disparity in the number of joints in the antennæ is worthy of any distinction further than a section. The *Forficula auricularia* is a small insect, about three quarters of an inch in length, having the wings folded under very short and truncate elytra or wing-cases, and the extremity of the abdomen armed with a horny forceps. When alarmed, the insect elevates the abdomen, and opens these forceps, in order to defend itself from the attack of its enemies.

EATING-OFF. The consumption of a crop or part of a crop by live-stock, on the field on which it grows and while it continues in an ungathered condition. Eating-off is a contrast to harvesting, and is practised almost exclusively with green crops, and principally with turnips. The prime design of it is the enrichment of the soil partly by the abrasions of the feet and body of the animals, still more by the decomposition of the rejected or uneaten portions of the crop, and chief of all by the intermixation of the liquid and solid excrements of the stock.

EAVES. The borders of a roof projecting over the tops of the walls of houses.

EBONY,—botanically *Diospyros Ebenum* and *Diospyros Ebenaster*. Two species of evergreen, tropical, timber trees, of the date-plum genus, and forming the type of the natural order Ebenaceæ. This order consists of trees and shrubs, some of them tender and evergreen, and others hardy, white-flowered, and deciduous; and it has, within the grounds and gardens of Great Britain, about a dozen hothouse species, upwards of 20 greenhouse species, and 4 or 5 hardy species. Upwards of one half of all these belong to the genus diospyros. See the article DATE-PLUM. Both of the two ebony species were introduced from India in 1792, and are distinguished for the well-known hardness, heaviness, and blackness of their timber, yet they share that character, though in a diminished degree, with many other species of their order. The mature ebenum is usually about 10 feet taller than the mature ebenaster, and has a height of between 30 and 40 feet. The ebony of commerce is imported principally from India, Madagascar, and the Mauritius; and is probably the production of not a few species of Ebenaceæ, particularly of the date-plum-trees. It exhibits great variety of general character, and very considerable variety even of colour, some being black, some green, and some reddish; and, coming at the same time from a wide range of latitude, and from regions where little knowledge of the specific differences of trees is possessed, it can scarcely be supposed to be furnished wholly or even principally by the true ebony trees. Most of it is exceedingly hard and heavy, and susceptible of a very fine polish; and all, or very nearly all of it is used for mosaic works, inlaid works, and the most handsome and elaborate specimens of fancy cabinet work. But a large proportion of nominal ebony is sheer imposition, neither ebenaceous nor in any sense foreign, but the mere timber of pear-trees and other home-grown trees, stained and doctored to deceive the ignorant.

The name ebony also belongs to a small genus of ornamental, greenhouse evergreens, of the hedysarum division of leguminous plants,—*Ebenus;* and the name Jamaica ebony is borne by a tall, evergreen, ornamental, West-Indian shrub,—*Brya ebenus*, formerly *Amerimnum ebenus*.

ECCALEOBION. A machine or apparatus for the artificial hatching of the eggs of poultry. It was invented a few years ago by Mr. William Bucknell; and takes its name from two Greek words which signify "the calling forth of life." It is capable of hatching 2,000 eggs in one brood, and is so constructed that, through glazed doors, they may be observed from without in all their successive stages of artificial incubation. The machine has a perfect and constant command over its interior temperature, from the ordinary condition of the atmosphere up to 300° of Fahrenheit; and it achieves the artificial hatching of eggs simply by means of steadily maintaining a degree of heat equal, or as nearly as possible equal, to that of the natural incubation of the hen.—The artificial hatching of the eggs of poultry has long been carried on to an enormous extent in Egypt; and, previous to the invention of the Eccaleobion, it failed in Britain, chiefly in consequence of the coldness and variableness of our climate, and of the want of artificial appliances for steadily producing an incubating heat. The number of hatching ovens, at one time, in Egypt, was nearly 400, each oven annually hatching about 8 broods, and each brood, on the average, comprising from 40,000 to 80,000 individuals; so that the supply of fowls by means of artificial incubation, annually amounted to nearly 50 for every individual of the human population!

ECCREMOCARPUS. A small genus of very handsome, evergreen, climbing, greenhouse plants, of the trumpet-flowered family. The rough species, *Eccremocarpus scaber*, called by David Don *Calampelis scabra*, was introduced to Britain from Chili in 1824, and is already a general favourite in our greenhouses. It usually has a height of about two yards, and carries orange-coloured, trumpet-shaped flowers in July and August. The name eccremocarpus signifies 'pendant fruit,' and the name calampelis signifies 'beautiful vine;' and both are descriptive of the plant. Another species, called the long-flowered, has been introduced from Peru.

ECHINARIA. A small genus of grasses, nearly allied to the dog's-tail grass tribe. The headed species, *Echinaria capitata*, called by some botanists *Cenchrus capitatus*, and by others *Sesleria echinata*, is a curious hardy annual, of 6 or 8 inches in height, flowering from May till August, and introduced about 75 years ago from the south of Europe; but it does not seem to be of any economical value. The genus takes its designation from the Latin name of the hedgehog; and is so peculiar as to constitute a sort of tribe or suborder of itself.

ECHINOCACTUS. A genus of tender, grotesque, and very curious and interesting plants, of the cactus family. They comprise about forty known species; and take their name from their supposed resemblance of form to that of a hedgehog, or from their having a sort of semiorbicular outline, marked with ridges, and profusely and powerfully armed with spines. Most have a height of only about six inches; but several are considerably larger. A species which became known in Britain about 7 years ago, *Echinocactus Vanderægi*, is the most interesting and one of the largest specimens of the genus. Its height is about 2 feet; its circumference is about 5½ feet; its ribs are angular and about 30 or 32 in number; each rib is armed with about 30 bundles of spines; each bundle of spines comprises one central spine of about 3 inches in length, and a circle of seven smaller spines; and the crown of the whole plant is densely clothed with a substance somewhat similar in appearance to white wool. See the article CACTUS.

ECHINOCHLOA. A genus of grasses, of the panicum tribe. The cock's-foot species, *E. crus-galli*, called by some botanists *Panicum crus-galli*, is an indigenous annual of our moist fields, usually growing to the height of about 20 inches, and flowering in July and August. Six or seven annual species, and one biennial, have been introduced from foreign countries; but they possess very little economical interest. The name echinochloa signifies hedgehog-grass, and alludes to the prickliness of the plants, particularly of the cock's-foot, the echinate, and the setigerous species; and it is sometimes popularly translated prickly-grass, or has that name as its English synonyme.

ECHINOPOGON. A small genus of grasses, of the agrostis tribe. The ovate species, *E. ovata*, called by some botanists *Agrostis ovatus*, is a perennial of about a foot in height from Australia. The name echinopogon may be translated "prickly-beard," and has the same kind of allusion as echinochloa.

ECHINOPS. See GLOBE THISTLE.

ECHINUS, or SEA EGG. A marine animal, inhabiting the seas of most countries, and subject to great variety in the species. *Echinus esculentus*, the edible sea egg, is common on the coast of Europe, and is esteemed as an article of food. In systematic arrangements, the genus echinus of Linnæus has been much divided, and is at present restricted to those species which have an orbicular, oval, or globular body, covered with spines, articulated on imperforate tubercles. These spines are very slightly attached, and fall off the dead animal on the least friction; in consequence, the specimens which commonly come under observation are deprived of them entirely. Five ranges of pores diverge from the summit, and tend to the centre beneath, dividing the shell into well marked sections. The mouth is situated on the inferior surface, in the centre, and is armed with five osseous pieces or plates, anus superior. Many species are ornamented with a profusion of long and pointed spines, while in others, they are quite short. It is by means of these spines that the animals change their position, and move from place to place. The apparatus of the mouth is provided with strong muscles, and is well calculated for crushing the hard portions of the animal's food. In the same species the colours vary considerably, the traits changing, however, on the death of the animal. Echini are said to retreat to deep water on the approach of a storm, and preserve themselves from injury by attaching themselves to submarine bodies. *E. melo* is perhaps the largest species known, and is found not uncommonly in the Mediterranean. Many fine species have been discovered in a fossil state imbedded in chalk, &c., in beautiful preservation. The species constituting the genus have not been well determined.

ECHITES. A large genus of ornamental plants, chiefly tropical, evergreen twiners, of the dog's-bane family. The suberect species, or savanna-flower, *Echites suberecta*, is a tender, yellow-flowered, evergreen twiner, of about 10 or 12 feet in height, and was introduced to Britain from Jamaica in 1759. It abounds on the dry maritime heaths of St. Domingo, and on the vast savannahs of some parts of tropical America; it grows wild in the immediate vicinity of Kingston in Jamaica; it appears to yield the active ingredient to much of the infamous South American poison, called wooraly or woorari; and it possesses a dismal celebrity, both in its native regions, and in the few British hothouses in which it is cultivated, as one of the most virulently poisonous plants in the world. A milky juice, with which all the plant abounds, is so potent that two drachms of it will kill a dog in eight minutes; and even the accidental impregnation of the water of a drinking-trough with a few of its flowers has been known to kill several mules. Great care should be used not to let any of its juice approach the eyes, or touch a wound or a scratch.—The antidysenteric species, *E. antidysenterica*, a pink-flowered, evergreen twiner of 6 or 8 feet in height, introduced from India about 25 years ago, is believed to have valuable medicinal power as an astringent and a febrifuge. The twin-spined species, *E. bispinosa*, a low, evergreen, pink-flowered undershrub, introduced about half a century ago from the Cape of Good Hope, is cultivated for economical purposes. Between 20 and 30 species, varying in height from one foot to twenty feet, have been introduced to British hothouses; and nearly 40 other species have been scientifically described. The name echites is formed from a word signifying "a viper," and alludes to the snake-like appearance of the twining shoots.

ECHIUM. See Bugloss (Viper's).

ECHO. When sound strikes against a distant hard surface, it is reflected, and heard again after a short space; this repetition is called *echo*. If the sound is repeated several times, which is the case when it strikes against objects at different distances, many echoes are heard. This phenomenon is not caused by a mere repulsion of the sonorous particles of air, for then every hard surface would produce an echo; but it probably requires a degree of concavity in the repelling body, which collects several diverging lines of sound, and concentrates them in the place where the echo is audible, or, at least, reflects them in parallel lines, without weakening the sound, as a concave mirror collects in a focus the diverging rays of light, or sometimes sends them back parallel.—Still, however, the theory of the repulsion of sound is not distinctly settled, probably because the nature of reflecting surfaces is not sufficiently known. The reflecting surface must be at a certain distance, in order that the echo may come to the ear after the sound, and be distinctly separated from it. Observation proves that sound travels 1,142 feet in a second; consequently, an observer, standing at half that distance from the reflecting object, would hear the echo a second later than the sound. Such an echo, then, would repeat as many words and syllables as could be heard in a second. This is called a *polysyllabic* echo. If the distance is less, the echo repeats fewer syllables; if only one is repeated, then the echo is monosyllabic. The most practised ear cannot distinguish, in a second, more than from 9 to 12 successive syllables, and, for a *monosyllabic* echo, a period of at least half a second is requisite. Hence we see why arched walks and halls echo, without producing a clear and distinct sound.—Some of the walls are too near; and some form an uninterrupted series of surfaces at different distances, and the ear is not able to distinguish the original sound from the first echo, nor to separate the numerous echoes which are thus confounded with each other. On the contrary, if several reflecting surfaces are at different distances, each of them may produce a distinct echo, of which the first is the strongest, because the others are weakened by a longer passage through the air. As the reflection of sound depends on the same laws as those which regulate the reflection of light, on which the science of *catoptrics* depends, the doctrine of echoes is sometimes called the *catoptrics of sound;* a better name is *cataphonics*, or *catacoustics*. The place of the sounding body is called the *phonic centre*, and the reflecting place or object, the *phonocamptic* centre.

EDDERS. Small shoots of ash, hazel, oak, or other indigenous trees, used for binding the tops of hedges.

EDDISH. See Aftergrass.

EDGE. The extreme border of a ridge, a field, a crop, or any other division of land or of sheets of cultivation. An edge-grown crop is one which has an irregular growth, and a successional ripening; and an edge-hoeing is the hoeing either of the borders of a patch or field, or of the sides of the ridges or rows of any growing, drilled crop.

EDGING. A dense line of small plants, or a continuous line of some dead substance, placed along the margin of a flower-plot or a garden border, to separate the soil of the plot or the border from the adjacent walk or alley. Any plot or border which is bounded by either a gravel walk or a grass alley requires an edging in order to prevent portions of its soil from being washed into the walk or alley by heavy rains. The common dwarf box, for all the purposes of utility, neatness, manageableness, durability, and economy, forms by far the best edging; but many other plants, particularly thrift, daisy, catchfly, none-so-pretty, and vernal gentian, are, in a considerable degree, suitable, and may, in many instances, be partially used for the sake of variety. Several aromatic plants, especially thyme, lavender, rue, and hyssop, were formerly used for edgings; but they very soon become woody, bushy, and unmanageable, and are liable to be more or less destroyed by the severities of winter. Edgings of box, in order to be constantly in a state of perfect neatness, should frequently be clipped; and edgings of thrift, daisy, none-so-pretty, and similar plants, in order to be even tolerably neat, require to be lifted, transplanted, or re-arranged every spring. Edgings of board have sometimes been used, but they are vilely vulgar; and edgings of wire, withes, and kindred materials have also become not uncommon, but they have an odious appearance, and look fitter for the street or the factory than for the garden.

EEL. A fish well known from its peculiar form and savoury flesh. Many varieties of eels are described by naturalists, some tenants of fresh-water streams, others inhabiting the sea. The latter acquire a vast size, and numerous instances are on record of their having attacked and overpowered boys, and even men, while bathing. Gifted with prodigious strength and agility, and capable of inflicting severe wounds with its powerful jaws, the sea eel, or conger, must prove a most dangerous assailant, when encountered in its native element. Fresh-water eels, inhabiting running streams with gravelly bottoms, are said to be uniformly white upon the belly, and infinitely more delicate than those of muddy waters, which are always yellow, and possess a peculiar smell and flavour, very disagreeable. In the choice of its food, the eel is far from cleanly, feeding indiscriminately upon all kinds of small fish, and decayed animal matter; in consequence of which, many persons refuse to eat them. In the seas of India, there are large species caught, varied with the most beautiful colours, resembling serpents; and one, in particular, has so much the aspect of one of these reptiles, as to bear the name of *snake eel*. The flesh of eels is sapid and nourishing, but, owing to its fatness, offensive to weak stomachs. Oil is procured from sea eels, which is remarkably clear, and burns very brightly. A curious opinion prevails in America as to the properties of eel-skins in preventing the cramp, so dangerous to bathers. Boys are frequently seen with one fastened round the ankle for the purpose of averting the attack of this dangerous spasm while in the water. It is needless to observe, that the virtues ascribed to it are very apocryphal. The Romans are said to have fed eels upon human flesh; and one of the most cruel of the emperors caused his slaves to be thrown alive into the fish-ponds for disobedience. A similar tale is related of Vedius Pollio. *Muræna* was the term used to express the male eel, and *myrus* the female.

The common eel belongs to the subgenus *muræna* of Lacepede, and may be distinguished thus: dorsal fin commencing very much in the rear of the pectorals; lower jaw shorter; colour, olive-green above, silver or yellowish beneath. In the sea eels, or congers, the dorsal commences near the pectorals, or over them, and the superior jaw is always longest. The conger attains the length of five or six feet, and the thickness of a man's leg. Some kinds of eels occur, in which there are no perceptible fins whatever. Few animals are more tenacious of life; they continue to move for a long while when deprived of the head and skin, preserving the muscular irritability for many hours after death.

EGG. The food and the embryo of a non-viviparous animal. Every species of young animal which is born alive is called viviparous; and every species which comes into being through the medium of an egg is called oviparous. Eggs, in the natural and true sense of the word, ranging from the enormous ovum of the ostrich down to the microscopic ovule of the almost microscopic insect, are exceedingly various in size and colour; yet those of insects have universally the character of developing larvæ, under the influence of mere chemical agencies, foreign to the bodies of their parents,—and those of birds have universally the character of developing, and incipiently feeding, the full-formed or perfect young of their respective species, under the influence of incubation or the steadily applied heat of the bodies either of their own parents, or of birds of very similar size and habit.

The eggs of some insects are deposited beneath the bark or skin of plants, and occasion diseases of the roots or stems or branches, by developing the larvæ to feed upon the juices; those of others are deposited in the leaf-bud or the flower-bud, and occasion the destruction of the embryo leaves and flowers, and prevent "the setting" of fruit, by developing their larvæ to feed upon the embryos; those of others are deposited in fruits and seeds, and occasion their damage or their utter destruction, by developing larvæ to feed upon their contents; those of others are deposited in the soil, and indirectly occasion great injury to vegetation, by developing their larvæ either to feed upon roots, or to ascend stems, or to riot among leaves and herbage; those of others are deposited in cheese, flesh, and other dead animal substances, and urge them into putridity, and occasion them to be overrun or to become "all alive" with larvæ; those of others are deposited beneath the skin of animals, not excepting human beings themselves, and, by the hatching and feeding of their larvæ, occasion very painful and most disgusting cuticular affections; and those of others are so deposited upon the exterior of horses, sheep, and some other animals as to be taken into the stomach, the frontal cavities or other parts of their interior, there, but without the infliction of either injury or pain, to develop and mature their larvæ. But, though well known and not very difficult of observation as to their habits or natural history, the eggs of insects are in general so very minute as not easily to admit of either mechanical dissection or chemical analyses; nor are they of almost any importance, or fitted to challenge any attention, except as giving origin to their respective larvæ.

The eggs of the multitudinous tribes and countless varieties of the feathered animals, are exceedingly similar to one another in all essential characters, and, excepting in the unimportant qualities of size and colour, may be all regarded as fully and accurately represented by the egg of the common farm-yard hen. Though, therefore, the eggs of all birds are interesting objects of examination, and though those of some species are objects of very great economical value to man, our remarks on the natural history of all, as well as on practical matters connected with them, may be restricted to the eggs of our common poultry.

An egg consists of four parts,—the shell, the enveloping membrane, the white, and the yolk. —The shell contains and protects all the other three parts; and consists, according to analysis by Dr. Prout, of two per cent. of animal matter, one per cent. of phosphate of lime and magnesia, and 97 per cent. of carbonate of lime, with a little carbonate of magnesia.—The enveloping membrane or *membrana putaminis*, is a thin, transparent pellicle, immediately within the shell, and constituting a sort of lining to it; but it is detached over part of the great end of the egg, so as there to leave a small space between itself and the shell to be occupied with air. This membrane consists of coagulated albumen; and, though so different in mechanical condition from the white which it encloses, is very nearly identical with it in chemical constitution.

The white of an egg is a glairy liquid, and is retained within the egg, in a manner similar to that in which the vitreous humour is retained in the eye, by means of an extremely thin and cellularly divided membrane. It consists, according to Dr. Bostock, of 4·5 per cent. of mucus, 15·5 per cent. of albumen, and 80 per cent. of water; it leaves, when evaporated to dryness, about 14 per cent. of its own weight of albumen; it coagulates, with a heat of 159° Fahrenheit, into a firm, semielastic, white solid; it yields by combustion minute portions of sulphuric acid, phosphoric acid, chlorine, potash, soda, lime, magnesia, and carbonates of potash, of soda, of lime, and of magnesia; but it has been proved to hold its sulphur and its phosphorus in an uncombined state, and to deliver them into the acid condition by oxygenizement during the process of combustion; and, notwithstanding its apparently very compound constitution, it affords an excellent, proximate, natural specimen of albumen. See the article ALBUMEN.

The yolk of an egg is a thick and almost solid yellow matter, enclosed within a peculiar membrane; and it is retained in the centre of the egg, or within a constant envelopment of the white, by means of two ligaments, called chalazæ, which attach it to the thin membrane of the albumen. Yolk boiled to hardness in distilled water consists, according to analysis by Dr. Prout, of 28·75 per cent. of yellow oil, 17·47 per cent. of albumen, and 53·78 per cent. of water; and its yellow oil, according to Planche, consists of 10 per cent. of stearin and 90 per cent. of elain,—the stearin white, solid, and very similar to the fat of fowls, and the elain strictly of the character of a fixed oil. Yolk, according to experiment and analysis by Dr. Prout, yields by incineration from 4·72 to 5·81 per cent. of ashes; and these consist of from 0·06 to 0·21 per cent. of the whole or unburnt yolk of sulphuric acid, from 0·28 to 0·44 of chlorine, from 0·27 to 0·51 of potash and soda and their carbonates, from 0·61 to 0·68 of lime and magnesia and their carbonates, and from 3·50 to 4·00 of phosphoric acid. But whether the sulphuric and phosphoric acids exist in the yolk in their formed state, or are formed by elimination of native sulphur and phosphorus during the process of combustion, is not known; though the probability is, that they exist in their native state, and that, even in contributing to form the phosphate of lime of the chick's bones in incubation, the phosphorus requires to pass through a double combination, first into the form of acid, and next into the form of phosphate.

The constitution of an egg exhibits very many and most striking evidences of the design and beneficence of the Creator, in the form of perfect and wonderful adaptations jointly to its immediate purpose of developing, feeding, and maturing an embryo bird, and to its incidental and secondary though scarcely less important purpose of affording food to man and to other animals. Yet so very numerous are both the chemical and the vital processes involved in the transmutation of its minute embryo into a perfect bird, that the exact provisions for some of the more recondite of them have hitherto eluded the scrutiny of the keenest human observation. A certain degree of porosity in the shell permits a comparatively free interchange of the gases of the atmosphere with the evolving gases of the interior; the detachment of a portion of the membrana putaminis at the great end of the egg permits a small and increasing volume of atmospheric air to be stored up there, as in a cell, for the ready use of the developing embryo; the membranous envelopments of respectively the white and the yolk, together with their two connecting ligaments, admirably preserve them from intermixture, while both the thinness of these envelopments and the ready permeability of their own interior just as admirably permit an interchange of influences or a mutual reaction of chemical power; and the peculiar composition of the shell most beautifully combines the properties of a strong shield, a porous sheath, a smooth coat, and a frangible or facile doorway; while the chemical elements of both the white and the yolk, besides possessing mighty mutual adaptation for developing the bird, are singularly eminent in nutrition, and exert almost the highest possible power as food both in the embryo bird and upon the digestive system of a human being.

Great chemical changes necessarily take place upon all the contents of an egg during the process of incubation; and if they could be examined and tested one by one or stage by stage, they would unquestionably unfold a manifold and most instructive display of the subordinations of chemical behaviour to vital action. When incubation is complete, all the interior has lost its dead matter, and is occupied with a perfectly formed animal, whose organization is as complex, intricate, and wonderful as that of an elephant or of man; the inert mass with its mainly chemical influences has almost wholly disappeared, and a perfect bird, with its mainly vital powers and its multitudinous organic functions, is present. "The albumen," remarks Dr. Thomson, "has disappeared, or is reduced to a few dry membranes, together with earthy matter. The yolk is considerably reduced in size, and is taken into the abdomen of the chick; while the animal has attained a weight nearly equal to the original weight of the albumen, together with that lost by the yolk, minus the loss of weight sustained by the egg during incubation. The alkaline matters and chlorine have diminished in quantity, while the earthy matters have considerably increased. During the last week of incubation, the yolk has lost most of its phosphorus, which is found in the animal converted into phosphoric acid, and, combined with lime, constituting its bony skeleton. This lime does not exist in the recent egg, but is derived from some unknown source during the process of incubation. Mr. Hatchett made the curious remark, that, in the ova of those tribes of animals the embryos of which have bones, there is a portion of oily matter, and in those ova whose embryos consist entirely of soft parts, there is none. In what way the oily matter contributes to the formation of bone, it is impossible, in the present state of our knowledge, to conjecture. Nor can any source of the lime of the bones be pointed out, except the shell; and it would be difficult to determine whether the shell loses lime during the process of incubation."

A new-laid egg has a specific gravity of from 1·08 to 1·09, or is from 0·05 to 0·06 heavier than sea-water; but every egg loses weight by exposure to the atmosphere, and soon becomes lighter than water; so that no egg should be used for testing the strength of brine except one which is new-laid or at least perfectly fresh. An egg exposed during two years to the open air loses considerably more than one-half of its entire weight; and one which was exposed during that length of time by Dr. Prout lost on the average 0·744 grain a-day, or diminished in total weight from 907·5 grains to 363·2 grains. But a powerful means both of retarding the loss of weight, and of greatly prolonging the freshness of eggs, is to anoint them, when taken from the nest, with fresh butter or hog's lard, so as to render the pores of their shells nearly impermeable by the oxygen of the atmosphere. The relative proportion of the weight of shell, of white, and of yolk considerably varies in different eggs; but it probably amounts, on the average, to 10·7 per cent. of shell, 60·4 per cent. of white, and 28·9 per cent. of yolk. A fresh egg usually loses about two or three per cent. of its whole weight by being boiled in water; it loses about one-third of a grain of this weight by surrendering a portion of its saline ingredients into solution in the water; and it appears to lose a main part of the weight by throwing off a portion of its contents in an aeriform condition while cooling,—for a boiled egg which is lifted suddenly from the boiling water and allowed to cool in contact with the atmosphere loses considerably more weight than one which is allowed to remain in the water till the latter has in a great degree cooled. A trace or portion of all the fixed principles of eggs is found in the water in which they are boiled; and that of the carbonate of lime is most abundant, and may be obtained in the form of a fine white powder by evaporation.

The progressive changes which eggs undergo during incubation, the proper keeping and managing of them for the bringing out of broods, and the gathering and general treatment of them in the poultry-yard, will be noticed in other articles. See the articles HATCHING and POULTRY. The value and palatability of eggs as an article of man's food, are universally known. The white is more digestible than the yolk; and an egg so slowly and cautiously cooked as to have a pulpy or thickly creamy consistency is both more agreeable and far more digestible than an egg which is boiled to hardness.—Eggs are always comparatively high priced in towns; and the great and general demand for them occasions a very extensive importation to the towns of Britain, at once from country districts, from Ireland, and from continental Europe. About 30 years ago, the trade in eggs from Berwick-upon-Tweed to London amounted in value to about £30,000 a-year; and about 15 years ago, the trade in eggs from France to Britain yielded about £83,000 a-year of prime cost to the French producers, and amounted in value to about £213,000 a-year to the British consumers. The internal trade from most country districts of Britain to the nearest great manufacturing towns, is very great, and in some places quite systematic; and, during a considerable number of years past, an enormously extensive and minutely ramified system of poultry-keeping is maintained throughout many of the sea-board districts of Ireland, particularly those of the counties of Londonderry and Antrim, for the regular supply of eggs by steam conveyance, to the great towns on the west coast of England and Scotland.—*Raspail's Organic Chemistry.—Thomson's Chemistry of Animal Bodies.—Turner's Elements of Chemistry—Quarterly Journal of Agriculture.—MacCulloch's Commercial Dictionary.—Fraser's Hand-book of Ireland.*

EGG-PLANT,—botanically *Solanum Origerum.* A curious, ornamental, esculent-fruited, annual, tropical plant, of the nightshade genus. It is extensively cultivated in the fields in hot countries, for the sake of its fruit; and it has been somewhat generally cultivated as one of the most interesting annuals of the hothouses of Britain, since about the end of the 16th century. It is called *Solanum melongena* by the older botanists, the egg-bearer by some English gardeners, aubergine by the French, corne di greci by the Italians, ocha by the West Indians, bahmia by the Turks, and brinjal and begom by the Hindoos. Its stem is prickly, downy, and about 2 or 2½ feet high; its leaves are prickly, downy and ovate; its flowers have a bluish or violet colour; and its fruit is a large ovate or globose berry, of such form and appearance as very readily to suggest the popular name of egg-plant. Four very distinct varieties of it are recognised in systematic botany,—the white-fruited, the purple-fruited, the red-fruited, and the yellow-fruited; but the first of these has such comparatively small fruit as to be merely a curiosity, while the second frequently carries fruit of individually 16 ounces in weight, and may be regarded as the eminently esculent variety. Specimens have been grown in England without artificial heat, and merely with the protection of a high paper frame, and in rich garden soil, with fruit of 5 inches in length and 8¾ inches in circumference, and of 7 inches in length and 6 inches in circumference. But the fruits produced in Britain have a bitterly-sweetish, acrid, burning taste, which is nauseous to almost every palate; and even those produced in the tropics are rendered palatable, partly by habitual use from childhood, and partly by very peculiar and delicate cookery. Yet they are generally used and highly relished in almost all hot countries, and even in France, Italy, and the West Indies. The Chinese are said to practise such nicety as frequently to cook the fruit while it continues suspended on the plant; and most or all of the nations who eat it have some methods, seemingly unknown to British cooks, of depriving it of its nauseous juices. The plant is raised in Britain in all respects as a tender annual; but it requires to be shifted from pot to pot; and it may be brought to fruit either in a greenhouse, in a vinery, or in a very warm open border.

EGLANTINE. See BRIAR (SWEET).

EHRHARTA. A genus of exotic grasses, of the subbiflorous family. It is somewhat allied to the panick-grasses; but it constitutes, with the genus microlæna, a kind of tribe of its own; and, in the Linnæan system, it stands far away from most of the other grasses, and has a place in the class hexandria beside the bamboos and the sweet flag. Upwards of a dozen species are known to botanists; and four of these, all greenhouse perennials, have been introduced to Britain; but they possess very little economical interest.

EJECTMENT, in Law. An action by which a person ousted from the possession of an estate for years, in lands or tenements, may recover that possession. But though the action is intended only for the recovery of a term for years, it is, in fact, used in England to try the title to an estate of inheritance or for life. In the early periods of the English law, the tenant, or person dispossessed of his estate for years, could not recover the possession of it, in this action, in the courts of law; he could only recover damages for the injury sustained by being driven from the possession; but the dispossessor kept possession of the term, just as is the case at present in the action of trover and conversion, in respect to a chattel, in which the owner does not recover the chattel itself, but damages for being deprived of it. But the court of equity, in this case, as in many others, led the way in ameliorating the law, and enlarged the remedy, so that the plaintiff might recover the term itself; and the courts of law, following those of equity, as early as Edward IV. adopted the same remedy, and awarded execution for putting the plaintiff into repossession of his estate, though no such thing was warranted by the writ, or prayed for by the declaration. After taking this step, the next one was to adopt the same form of action for trying the title to the lands. This application of the action of ejectment was made as early as the time of Henry VII. To do this, the person who claimed an estate of inheritance, of which another was in possession, entered upon it, and then made a lease, and the lessee took possession, and remained upon the land in virtue of the lease, until the person claiming under an adverse title put him out; or, if no such person appeared to expel him from the land, he pretended to be driven off by the first person who happened to pass that way, and who was thence called the *casual ejector*, who was, in fact, no ejector at all. Being thus ejected in fact, or by fiction, he brought his action of ejectment, or the party claiming the title brought it in his name, and in this suit the title was necessarily brought into question; for, in order to get possession, he must prove that he had a good and valid lease, which he would endeavour to do by showing that the lessor had the right to make such a lease, that is, that he had the title and right of possession. When the object was to try the title, the lease, entry and ouster were a mere ceremony, and might as well be supposed or imagined as actually to take place. The courts, accordingly, allowed a fiction of the lease, entry and ouster; the plaintiff stated them to have taken place, though there had, in fact, been no such thing, nor was there any such person as the one named as being the lessee, who, in England, is always John Doe. Thus the action of Doe or Jackson *ex dem.* [*demisso*] Johnson, against Sampson, means the action of Doe or Jackson, the lessee of Johnson, against Sampson. If the nominal plaintiff, Doe or Jackson, were liable to be called upon to show himself to the court, there would be an end of the suit, as there would be no such person to be found. Nor would the demandant succeed any better, were he called upon to prove that there had been any such lease, entry or ouster; as all this is a fiction. Formerly, the defendant also, the casual ejector, as well as the plaintiff, was a man of straw, or little better; for he was frequently a person who accidentally came in sight at the time of making the lease, if there was any in fact made, and who would not be disposed to trouble himself to prevent the demandant from getting possession of land, in which he himself had no interest or concern; or he might be a friend of the demandant, who had come upon the land at his request, to act as ejector, and would be very willing that the demandant should recover it. The tenant, therefore, who is in actual possession of the estate, unless his right is defended by some other person than the indifferent defendant whose name appears on the docket of the court, is likely to lose his inheritance. To prevent this, the court allows him to appear himself, and defend against the claim and the court; always requires that notice shall be served upon him, to give him an opportunity to appear. But before the court will permit him to appear for this purpose, they require of him to admit all these fictions of a lease to John Doe, his entry and ouster, which he is willing to do rather than lose his land. These being admitted by him, he may then proceed to defend the action, and try the question, whether he has a better right to continue in possession, than this supposed John Doe has to recover the possession, upon his supposed lease. The titles of the demandant and tenant are thus brought into comparison, and decided upon. But when the object is, in fact, to recover a term for years, of which the demandant has been dispossessed, the lease, entry and ouster are of importance, and must be proved.

ELABORATION. The process by which some organs of vegetables, and particularly their leaves, recompose and prepare for final assimilation the gaseous aliment inhaled through the epidermis and the liquid aliment absorbed by the spongioles. The principal aliments elaborated are the atmospheric air received by the leaves, the ascending sap of the plant or the digested juice of the soil received by the spongioles, and ammoniacal gas partly received by the leaves along with the atmospheric air, and partly received by the spongioles from solution in rain water. The process of elaboration effects such chemical changes as to convert the gases and the sap of inhalation and absorption into the cambium which descends and becomes fixed. The series of changes upon the food of vegetables which may be regarded as analogous to digestion takes place in the soil; and the series of changes effected by elaboration is peculiar to vegetables, or may, in some respects, be viewed as a contrast or counterpart to those of animal respiration. See the articles ABSORPTION, CAMBIUM, and ANALOGY.

ELÆAGNUS. See OLEASTER.

ELÆIS. A genus of indigenous, tropical, economical trees, of the palm family. The Guinea species, or oily palm, or maba, *Elæis guineensis*, abounds upon nearly all the western coast of Africa, and was introduced, about 115 years ago, to the palm-houses of Britain. Its stem is rough, bristled with the spiny remains of the fallen leafstalks of former years, about 10 inches in diameter, and about 30 or 35 feet in height; its fronds have a length of about 15 feet, and are winged with two rows of ensiform folioles, each about 18 inches in length; and its fruit is ovoid, golden-coloured, and about the size of a pigeon's egg, and has a covering similar to that of the cocoa-nut. A richly flavoured palm oil, similar in fragrance to the root of the Florentine iris, and of an orange-yellow colour and butyraceous consistency, is obtained from the fleshy portion of the fruits of this palm by first bruising it into a pasty condition, and then macerating it in boiling water. This oil is used by the Africans in cookery and unction, and it constitutes a considerable proportion of the well-known palm oil of commerce. The Guinea elæis is cultivated in the West Indies, and was introduced thither from Africa. Three other species or varieties of elæis, the Pernambuco, the western, and the black-seeded, have, within the last quarter of a century, been introduced to British palm-houses from respectively Brazil, the West Indies, and New Grenada. The name elæis signifies "olive-like," and alludes to the sweetness and abundance of the oily produce.

ELÆOCARPUS. A genus of tender, evergreen, ornamental, dendritic plants, forming the type of the natural order Elæocarpeæ or Elæocarpaceæ. This order, so far as yet known, occurs only in the hot parts of the world; and, except for the tender habit of its plants, and for their flowers having fringed petals and two-pored anthers, it might be justly and thoroughly merged in the order of our European lime-trees. Very few species of it, though species belonging to four genera, have as yet been introduced to Britain. About a dozen species of the genus elæocarpus are known; and two of these, the saw-leaved and the blue-fruited, are somewhat well-known to British gardeners. Some of the species have fragrant flowers and eatable fruits; and the seed-nuts or drupes of some are hard, rugose, curiously sculptured, and susceptible of a fine polish, and are, in many instances, set in gold and strung into necklaces. The name elæocarpus signifies "olive-fruited," and alludes to the form and qualities of the fruit.

ELAIN. The oily principle of fat, obtained by submitting fat to the action of boiling alcohol, allowing the stearin to crystallize, and then evaporating the alcoholic solution; or, by the simple process of pressing any oily or fatty substance between folds of bibulous paper, the oily matter or elain is absorbed, while the stearin remains. The paper being then soaked in water, and pressed, yields up the elain. It possesses much the appearance and properties of vegetable oil, is liquid at the temperature of 60° Fahr., and has an odour derived from the solid fats from which it has been extracted. It is readily soluble in alcohol, and forms soaps with alkalies; in doing which, however, it undergoes decomposition, and is converted, according to Chevreul, into a peculiar acid, called by him *oleic acid*, which combines with the alkali employed. This acid is obtained by submitting the soap formed by the action of potash on hog's lard to the action of boiling water; the solution, on cooling, deposits a sediment, consisting of the margarate of potash, while the oleate of potash remains in solution. The oleate of potash is decomposed by tartaric acid, again combined with potash, and again decomposed by tartaric acid, when the oleic acid rises to the top in the condition of an oily-like fluid. It is insoluble in water, soluble in alcohol, reddens litmus, and combines with the different salifiable bases, forming compounds somewhat analogous to soaps. At a temperature of 35° Fahr., it congeals into crystalline needles.

ELASTICITY. The peculiar property of bodies, by virtue of which, the particles of which they are composed, when moved out of their positions by an external force, or pressed into a narrower space, tend to return to their former position, as soon as the external force ceases to act. A bow, bent by the tension of the string, recovers its previous form when the tension is relaxed. Let an ivory ball fall upon a plate of marble, it is partially flattened by the impulse, but becomes immediately round again as soon as the force of the blow is destroyed. Here we see the cause of its rebounding from the hard surface. Feathers are in a high degree elastic. This property of elasticity is particularly observable in atmospheric air. If it is enclosed in a vessel, and pressed with a piston, as soon as the force is removed from the piston, the air throws it up violently. This is the principle of the air-gun. There is an important difference between the elasticity of solids and fluids; the former tend to recover their previous form; the latter to expand into a greater space, whence the term *expansibility* is applied to them. For the sake of distinction, the elasticity of solid bodies may be termed attractive, and that of fluids, expansive. The degree of it is very different in different bodies, and in many it is increased by art. Those bodies in which it cannot be perceived at all are called *unelastic*. The elasticity of a solid body is greater the more its particles are expanded. If all the particles of a body are so far expanded that their elasticity is just equal to the expansive power, the expansion can be carried no further without separating the particles. The weights necessary to produce a given degree of extension, must be proportionate to the extension already existing. If three cords, of the same size and substance, stretched in proportion to the numbers 1, 2, 3, are to receive each a given amount of additional extension, the weights necessary to produce this extension are as 1, 2, 3. The laws of elasticity in fluids are different from those in solids. In heavy elastic fluids, the inferior layers support the weight of its superior; in a cylindrical vessel, therefore, the bottom suffers the pressure of the whole mass of elastic fluid, and the lower strata are sensibly denser than the upper. A difference is made, too, between absolute and specific elasticity. By the former is understood the peculiar property of bodies to repel a pressing force, in itself, and without regard to temperature and density. This must be always equal to the pressing force. But as different kinds of matter may press with equal force under unequal densities and temperatures, that is called specifically most elastic, which with a less density presses with a force equally strong, and with an equal density stronger. In all elastic fluids, the specific elasticity increases with the temperature; it is likewise augmented by greater density: if air is confined, and made more dense, its specific elasticity is greater in proportion to its increase of density.

ELATER. A genus or group of coleopterous insects, forming the type of the order Elateridæ. About 60 genera and upwards of 500 species of elateridæ are known to modern entomologists,—all possessing characters strictly similar to those of the genus elater as constituted by Linnæus; and about 70 of the species more or less abound in Britain, and in some instances are known, in other instances are suspected, to be the parents of the numerous kinds of wire-worms which so dreadfully infest the crops of the farmer. These insects, when they fall upon their back in dropping from plants to the ground, have the power of regaining their natural attitude by means of a smart leap into the air, and of half a somerset; and from this circumstance, they derive the entomological name of elaters, and the popular names of spring-beetles, skip-jacks, click-beetles, snap-beetles, and blacksmiths.

The body of an elater is comparatively long; the head, in most instances, has a deep insertion in the thorax; the thorax is not so broad as long, and generally about the same width as the elytra, and projects behind into acute angles, and even, in most instances, into spine-like continuations; the elytra cover the abdomen, and are long and narrow; the antennæ are either filiform, serrated, or pectinated, and have a comparatively medium length; and the legs are short and somewhat slender. When the insects are alarmed or approached while they are upon a plant, they draw their antennæ and their legs close to their body, and let themselves drop to the ground; and when they fall upon their back, and regain their natural attitude by their peculiar leap, they bend the body backward into the form of a curve or angle, rest their whole weight upon the fore-extremity of the thorax and the hind-extremity of the abdomen, and make a sudden muscular relaxation or twitch somewhat similar both in nature and in clicking sound to that of the snapping of two finger-nails of the human hand. They walk and run with their heads hanging down and their noses close to the ground, in the manner of dogs; they readily run up the culms of grasses and fly to the flowers or summits of herbaceous plants; and, though the parents of one of the most mischievous and long-lived group of larvæ with which cultivators of the soil have to combat, they are themselves both harmless and short-lived, and appear, like the butterflies and the bees, to draw their main sustenance from the sweets of flowers. Some species are frequently met with upon the ground; but most are rarely seen except on the flowers, leaves, and other elevated parts of plants.

Some of the most destructive and abundant wire-worms or root-worms have been thoroughly identified with the larvæ of four species of elateridæ; and others have very probably, though not quite certainly, been identified with the larvæ of eight other species of elateridæ; but many—on account of their very close similarity to one another, and of their living through the long period of four or five years before undergoing transmutation into pupæ and perfect insects—continue to be totally unidentified with any particular species; and a few somewhat rare destroyers, popularly classed by farmers and gardeners with the wire-worms, have been ascertained to be, not wire-worms at all, but the larvæ of crane-flies and other genera of dipterous insects.

The inability of entomologists to identify more than a small number of elateridous larvæ with precise species of wire-worms is our principal motive for discussing the elater and the wire-worm in mutual distinct articles; and it ought also to be a reason, and a powerful one, for every scientific farmer or gardener picking up specimens of every doubtful elater, and especially of every specially devastating wire-worm, and using his best efforts to nurse and trace them up to their transformation.

The four species whose larvæ have been thoroughly identified with abounding and destructive wire-worms are *Elater sputator* of Linnæus, *Elater variabilis* of Herbet, or *Agriotes sputator* of most modern entomologists,—*Elater obscurus* of Linnæus, *Elater variabilis* of Fabricius, *Elater obtusus* of De Geer, *Agriotes obscurus* of Eschscholtz, or *Cataphagus obscurus* of the most recent British systems of entomology,—*Elater lineatus* of Linnæus, *Elater striatus* of Panzer, *Elater segetis* of Gyll, *Agriotes lineatus* of Eschscholtz, or *Cataphagus lineatus* of modern British entomologists, —and *Elater ruficaudis* of Gyll, *Elater sputator* of Olivier, *Elater analis* of Herbet, *Elater hæmorrhoidalis* of Fabricius, and *Athous ruficaudis* of Eschscholtz. The eight species whose larvæ are probably or presumptively, but not quite certainly, identified with wire-worms, are the satin-coated click-beetle, *Elater* or *Lepidoptus holosericeus*,—the mouse-coloured click-beetle, *Elater* or *Agrypnus murinus*,—the tawny-legged click-beetle, *Elater* or *Melanotus fulvipes*, or *Elater castanipes*,—the spitting click-beetle, confounded in scientific name with one of the four species whose transformations are thoroughly known, *Elater* or *Agriotes sputator*,—the black click-beetle, *Elater* or *Athous niger*,—the margined click-beetle, *Elater* or *Dolopius marginatus*, or *Elater saturalis*,—the pointed click-bettle, *Elater* or *Adrastus acuminatus*,—and the long-necked click-beetle, *Elater* or *Athous longicollis*. See the article WIRE-WORM.

ELATERIUM. A genus of plants of the gourd family. Two hardy annual species, the Carthaginian and the tamnus-like, both yellow-flowered twiners of about 5 or 6 feet in height, were introduced to Britain about 25 years ago from respectively Carthage and Mexico, and are cultivated in a manner similar to the varieties of *Cucumis sativus*, but with attention to their climbing habit. Six or seven other species are known to botanists. The name elaterium seems to have been given by the ancients to several very different vegetable substances, particularly to violent purgatives; nor is it uniquely and consistently used even by the moderns,—for it figures at present, in therapeutic treatises, as the designation of a species of momordica. See the next article.

ELATERIUM,—botanically *Momordica Elaterium*. A hardy, perennial-rooted, trailing, medicinal plant, of the gourd family. It is a native of the south of Europe, abounds in the vicinity of Constantinople, and was introduced to Britain about the middle of the 16th century. Its root is large and fleshy; several stems grow from each root, and are thick, rough, and trailing, and branch out three or four feet in every direction; the leaves are cordate, large, rough, and greyish-green, and stand on long footstalks; the flowers have a pale-yellow colour with a greenish base, and are similar to those of the cultivated cucumber, but smaller; and the fruit resembles a small, greyish, prickly, oval cucumber, and, when ripe, falls from its footstalk, and ejects to a considerable distance, through the hole of the footstalk, both its juice and its seed. The appearance and habit of the fruit have often occasioned the plant to be popularly called the squirting cucumber. The fruit, in order to yield the elaterium of medicine, should be gathered before being ripe, cut longitudinally up, divested of its seeds, and freed of all its adhering juice by washing; and its contents should be passed through a sieve, and allowed to stand till they deposit a fine sediment, and this should be freed from the incumbent liquid, and dried upon linen cloth. But much of the elaterium of the shops is obtained merely by the inspissation of the expressed juice. Good elaterium is light, pulverulent, yellowish or slightly greenish white; and has scarcely any smell, and a very slightly bitter taste. It is an exceedingly powerful cathartic, and is often prescribed in cases of dropsy; but in over-dose it produces deadly purging in man, and in even moderate dose is a downright poison to the horse. Elaterium contains 39 per cent. of ligneous fibre, starch, and earthy matter, 21 per cent. of a green resin, and 40 per cent. of a crystalline principle. The green resin is believed to contain all the peculiar or active powers of the medicine, and has been designated elatin; and the crystalline principle is obtained in the form of colourless acicular tufts, has a bitter taste, and possesses neither acidity nor alkalinity.

ELATINE. See TOADFLAX and WATERWORT.

ELBOW. The hind part of the fore-leg of a horse.

ELDER,—botanically *Sambucus*. A genus of hardy, ornamental plants, principally deciduous shrubs and small trees, of the honeysuckle family. The common or black elder, *Sambucus nigra*, is a well-known, abundant, indigenous, shrubby tree of Great Britain. It grows wild in many situations, particularly in hedges and on the margins of fields, on almost all kinds of soil; and is popularly known, in some districts, as the bore-tree or bower-tree. Its stem has a roughish grey bark, is profusely branched toward the top, and usually attains a height of about 15 feet, but can easily be coaxed up to a height of 30 feet; its wood is white and hard, and has a wide, soft, spongy pith, and, though very brittle in young shoots, is tough in old branches, and timbery and valuable in large old stems; its leaves are compound, each consisting of five or seven oval, pointed, serrated, dark-green folioles; its flowers are produced in large terminal cymes, and have a creamy-white colour, a bitterish taste, and a faintish sickly odour, and bloom from May till July; and its fruit are globular, inodorous, sweetish-tasted, purplish black berries, containing in their juice vegetable jelly, saccharine matter, and malic acid.

This plant, especially when topped, kept down, and maintained in a strictly bushy form, either singly or in small clumps, or in short hedge-rows, is a popular favourite as an ornamental plant, and makes a conspicuous figure in situations, such as some of the town-parks and market-gardens of Edinburgh, which are abundantly worthy of far finer decorations as to at once delicacy of foliage, beauty of outline, and agreeableness of odour. The elder, in fact, is a sickening plant, totally unfit for the near vicinity of human abodes; and though broadly showy at a little distance, is far too hoydenish to figure in a shrubbery or on the boundary of either a garden or a lawn. Yet a single tree or a small clump, in consequence of its being sheeted all over with its large close cymes, makes an imposing appearance, during the season of bloom, in a corner of a plantation, or on any other suitable spot at a sufficient distance from places of resort. The elder has been recommended, on account of its cheapness, hardiness, and habit of rapid growth, as a very suitable plant for hedge-fences; but it requires to be planted thickly, to be allowed to grow for some time untouched, and to be headed down and periodically topped to the required height of the hedge; and, even in spite of such treatment, it can never produce the closeness and thorough imperviousness of a good or even an ordinary thorn fence. Its leaves kill several species of noxious insects, offend and banish moles, and are greedily eaten by sheep,—and on these accounts, might seem to render the plant desirable; but they are disliked by cattle, and are offensive to man, and probably act, more in the way of medicine than in the way of aliment, upon sheep. The flowers and the berries are used in pharmacy as diaphoretics and aperients. The flowers are used in fomentations and cooling ointments. The leaves boiled in lard make one of the most emollient and suppling unguents known to the farrier. The berries were formerly used for fevers, gout, rheumatism, and cutaneous affections. The bark is a hydragogue purgative,—of reputed efficacy in dropsy; and, when given in large doses, acts also as an emetic. The flowers are used for making a perfumed distilled water. The berries, according to experiments by M. Aloys Wehrle of Vienna, produce a comparatively much larger quantity of spirit than can be obtained from the malt of the best wheat. The juice, in M. Wehrle's experiments, was expressed from the berries, treated in the same manner as the must of grapes, and afterwards distilled.

A number of quite distinct and well-established varieties of the common elder are in cultivation; all similar to the normal plant or identical with it in form, colour, and malodour of their flowers, but most of them differing in the properties of the leaves, the buds, the bark or the berries.—The parsley-leaved variety, *S. n. laciniata*, has its leaves so intricately cut as to resemble those of parsley, differs so widely in the appearance of its foliage from the normal plant as to be frequently pronounced a different species, and, but for the sickening smell of its flowers, might be a most welcome member of any shrubbery.—The white-berried variety, *S. n. leucocarpa*, or *S. n. albida*, is distinguished by a whitish tint in its berries, by a whitish tinge in its young buds and in the bark of its young shoots, by a lighter green than the normal plant in the colour of its leaves, and by a mitigated degree of unpleasantness in the odour of its flowers.—The greenish variety, *S. n. virescens*, or *S. n. viridis*, is distinguished by the greenish colour of its berries, and by a shade of colour in its bark between that of the white variety and that of the normal plant. —The other principal varieties are sufficiently described by their respective designations,—the monstrous or striped-barked, *S. n. monstrosa;* the roundish-leaved, *S. n. rotundifolia;* the yellow variegated-leaved or the gold-striped, *S. n. foliis luteis* or *S. n. aurea;* the white variegated-leaved or silver-striped, *S. n. foliis argenteis* or *S. n. variegata;* and the powdered or silver-dusted, *S. n. pulverulenta*, the leaves of this last being pounced or dusted over with a very fine powder, so as to give the plant a striking and beautiful appearance.

The racemose or mountain elder, *Sambucus racemosa*, was introduced to Britain from the south of Europe toward the close of the 16th century. It usually attains a height of about 12 feet, and forms a beautiful and universally admired small tree. Its young bark is reddish; its buds, in winter, are large, turgid, and red; its leaves are pinnatifid, and change to a reddish colour in autumn; its folioles are serrated, and stand at good distances from one another on the long midrib; its flowers are produced in oval-shaped cymes or bunches: and its berries also grow in oval bunches and have a deep scarlet colour, but are somewhat shy and inconstant in forming. Marshall speaks highly of this plant as an ornamental one, and says, "The reddish-coloured branches, with their large turgid buds, have a singular and noble look in winter amongst other trees; and in the spring, as flowering shrubs, these trees seem to attempt to vie with any of the flowering tribe; for in April and the beginning of May, they will produce their bunches of flowers at the ends of every joint of the last year's shoots." Two very distinct varieties of the species are in cultivation, the purple and the flavescent.—The Canadian or American elder, *Sambucus canadensis*, is a white-flowering shrub of 6 or 8 feet in height, introduced from North America in the latter half of last century.—The downy elder, *Sambucus pubens*, is a shrub of about the same height as the preceding, with greenish-yellow flowers, introduced from North America about 35 years ago.—The ebulus or dwarf elder, *Sambucus ebulus*, is a perennial-rooted herbaceous weed of the waste grounds of Britain, rising to the height of 3 or 4 feet, carrying whitish pink flowers in June and July, and rapidly propagating itself by its creeping and vivacious roots.—About half a dozen other species are known to botanists.—*Loudon's Hortus Britannicus.—Miller's Gardener's Dictionary.—Marshall on Planting.—Quarterly Journal of Agriculture.—The Bath Papers.—Transactions of the Highland Society.—Nicol's Planter's Calendar.—Thomson's Dispensatory.—Youatt's Works.—Clater.*

ELECAMPANE,—botanically *Corvisartia Helenium.* A hardy, perennial-rooted, ornamental, medicinal, indigenous, herbaceous plant, of the thistle division of the composite family. It is called by the older botanists, and even in some quite modern works, *Inula helenium.* It grows wild in rich moist meadows in Essex, Surrey, and other parts of Britain. Its roots is thick, branched, externally brown or grey, and internally white; its stem is round, furrowed, leafy, branched near the top, and about 4 feet high; its leaves are large, ovate, serrated, deep green above, and whitish and woolly below; and its flowers are terminal, solitary, large, and of a golden yellow colour, and bloom in July and August. The roots, principally of garden plants, have long been used as tonics, deobstruents, diuretics, and expectorants; but they have lost much of their medicinal celebrity, and are seldom esteemed of much value by regular practitioners. They are taken up when two or more years old, dried, and used principally in decoction.

ELECTRICITY. An imponderable and exceedingly subtle fluid, or more probably two mutually allied and reacting imponderable fluids, of universal diffusion through our world, and of vast controlling power over the agencies of chemistry and meteorology. Amber, called in Greek "electron," was observed by the ancients to possess the capacity of becoming so excited by friction as to attract to itself, and to hold for some time in suspension, loose pieces of feather or other light bodies placed in its vicinity; and glass, sulphur, sealing-wax, and multitudes of other substances, were, in the course of time, observed to possess the same wonderful capacity, and, in allusion to amber, were designated electrics. When the power acquired by these substances became somewhat well known, and was obtained in considerable accumulation, it was found to exert a surprising degree of activity, and to be sometimes accompanied by the evolution of crackling sounds and sparks of brilliant light; and it was supposed to be a distinct though obscure element, and was designated electricity. Theory enthusiastically ascribed to it the highest therapeutic properties; and medico-chemical practice eagerly constructed a machine for commanding quantities of it at will, and pouring them at a touch upon the animal frame of invalids. The electric-machine, about half a century ago, was cried up throughout Europe as an universal and almost thaumaturgic healer; and it eventually lost its therapeutic reputation, not because its healing virtues were either imaginary or feeble, but because an enormous overrating of them, and an indiscriminate, empirical, and quackish application of them, brought them into discredit and contempt.

"In the time of Grey, a supply of electricity was obtained for experimental purposes by rubbing a glass tube with the dry hand. Glass globes made to revolve by machinery were afterwards substituted for the tube, the friction being at first produced with the hand, and subsequently by means of a fixed rubber. As now constructed, the electrical machine is formed either with a cylinder or plate of glass, which is pressed during its rotation by cushions stuffed with hair. The cushion is usually covered with an amalgam of tin and zinc, which, partly by increasing the friction, and partly by the oxidation of the metals, materially assists the action of the machine. The electricity developed on the glass is conducted away by an insulated bar of brass placed close to it, called the prime conductor, on which it is collected in considerable quantity. By this means, the electricity spread over the whole surface of the prime conductor may be carried off at the same instant, and thus act with far greater power than if accumulated on glass or any other imperfectly conducting substance."—[Turner's Chemistry.]

The electric excitement obtained by the action of the machine is easily proved to be evolved out of the ground; for when the whole apparatus is separated from the ground by the intervention of a non-conducting substance, the evolution of the electric power immediately ceases,—and when the apparatus is again placed in contact with the ground, the evolution immediately recommences. The solid earth, or at least the crust of the world, is hence inferred to be a vast reservoir of electricity. A suspicion was for some time entertained that this electricity is identical in nature with the power of the thunder-cloud or the vivid flash of the lightning; and this suspicion was fully verified by a series of experiments on the part of several of the most distinguished philosophers of Europe,—but chief of all, on the part of the celebrated Franklin of America. Electricity was now known to abound in both the atmosphere and the solid earth, and to be an agent as universally diffused as it is mighty; and it henceforth became recognised as a chief controlling power of weather,—as the presiding element in vicissitudes, winds, hail-storms, heat, and thunder-bursts,—and as the grand subject of the scientific agriculturist's investigation in everything connected with meteorology. Subsequent discoveries, many, great, and startling, on the part of Davy, Faraday, and other master-minds in the walks of chemistry and physical philosophy, have convincingly identified electricity with both magnetism and galvanism, and detected its agency in some of the most important phenomena of both vegetable and animal existence, and proved it to have a most intimate connexion with the cultivation of the soil and with other arts which are in any degree dependent on the operations of natural chemistry.

So vast a subject, so wonderful in its history, so all-pervading in its scientific relations, and so obscure and intricate in many of its phenomena, is clearly unsuited for discussion in our pages. A moderately full examination of it would enormously exceed the limits which we could afford to it, and would, at the same time, drag us through an hundred scientific or theoretic inquiries of no possible interest to either gardener or farmer. We refer any readers who may desire extensive acquaintance with it to the writings of Davy, Franklin, Higgins, Priestley, Eeles, Edwards, Brewster, Arago, Faraday, Whewell, Thomson, and Leithead, or to particular treatises upon it in the Library of Useful Knowledge, the Magazine of Domestic Economy, the Mechanics' Register, the large Encyclopædias, and the best systematic works on Chemistry; and we must restrict our own observations to a very brief view of two of its most direct relations to the arts of culture,—its evolution from the soil as affecting vegetation, and its power over vegetable organism as affecting the germination of seeds and the growth of plants.

The evolutions of the electric fluid from the earth, or the sources and media of supplies of it to the atmosphere, occur not only in friction, but also in chemical action, in contact of hard bodies, in rise of temperature, in evaporation, and in the gaseous excretion of plants; and the last two of these possess special interest for the cultivator of the soil. The evolution of electricity from the gaseous refuse of plants, in particular, is both curious and instructive. Mr. Pouillet ascertained by experiment that the combination of oxygen with the elements of living plants disengages, in a single day, from a fully verdant surface of rather more than 100 square yards, a quantity of vitreous electricity sufficient to charge a powerful battery. He applied to the ground, while it was in the negatively electric condition, a delicate instrument for ascertaining the presence and intensity of the electric fluid, and he found that, while seeds of various kinds were in the course of germinating, the instrument was sensibly affected. Carbonic acid, during its nascent evolution from the combustion of charcoal, was previously well known to chemists to be in the positively electric condition; and as this gas is a great and voluminous aeriform refuse of all germinating seeds and growing plants by day, the ascent of it with the evolution of electricity necessarily implies the ground to be in the negatively electric condition. But when, on the other hand, during the short sleep of plants in the dark period of the night, carbonic acid ceases to rise, and a small proportion of oxygen is given out, the electricity accompanying the disengagement of the oxygen is negative and that of the ground is positive.* Thus are living plants, the grasses of the field, the cryptogams of the morass, and the trees of the forest, the media of maintaining the equilibrium between the electricities of the ground and the electricities of the atmosphere; and—by one of those simple, perfect, and beautiful arrangements which everywhere characterize the wisdom of the all-benign Deity in his works—these organic beings, in the very performing of the functions of their own existence, both keep up the due proportions between the carbon and the oxygen of the air, and the proper balance between the electric forces above and the electric forces below, and thus maintain both the salubriousness and the general calm of the atmosphere, for the life and comfort of man and the lower animals. M. Astier found that insulated spines of plants, when exposed to the atmosphere during the disturbance of the electrical equilibrium, acted as conductors of the electric fluid, or sensibly affected the electrometor; and "he thinks"—says a French work on scientific agriculture—"that the spines and the leaves of vegetables, both perform the office of constantly maintaining in the plants the quantity of electricity requisite for their own life and growth, and possess a power akin to that of thunder-rods, or a power of averting lightning, of preventing hail, and of keeping up the equilibrium between the earth and the clouds."

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* "By rubbing electrics on one another, the distribution of the electric fluid they contain is altered; and, on separating them, more than the natural quantity remains with the one, and less with the other. The one is then said to be electrified *plus* and the other *minus*, or *positively* and *negatively*. When two bodies are both electrified positively, or both negatively, they repel one another; but if one of them be electrified positively, and the other negatively, they attract one another. Instead of this distribution of the same fluid, the existence of two fluids has been assumed, each of which repels its own particles, but attracts those of the other; and this assumption is more favourable for the explanation of the chemical agency of this fluid."—[Dr. A. Thomson.]—"Dufay observed that an electrified substance not only attracts light bodies, but causes them after contact to fly off from its surface as if by a principle of repulsion. He likewise noticed that the electricity excited on glass is different from that of resin, and he hence inferred the existence of two kinds of electricity, the *vitreous* and *resinous*, the former belonging to glass and the latter to resin. He established an excellent mode of distinguishing them, by finding that substances possessed of the same kind of electricity always repel each other; and that attraction is as uniformly exerted between substances which are in opposite states of electrical excitement. Another fact of consequence was discovered by Mr. Symmer, who found that, when two bodies are rubbed together, both are excited, and that one always possesses vitreous and the other resinous electricity. This induced Symmer to modify the doctrine of two electricities. Dufay conceived vitreous electricity to be peculiar to some substances, and resinous electricity to others. Symmer, on the contrary, maintained, that bodies in their ordinary unexcited condition contain both kinds of electricity in a state of combination; and as they then neutralize or counteract each other's effects, no electrical phenomena are apparent; that friction produces excitement by separating the two principles; and that excitation continues until that kind of electricity, which has been withdrawn, is restored. Dufay's doctrine of the two electricities, as modified by Symmer, is at present extensively adopted. Agreeably to this theory, as now understood, there exist two electrical fluids, both equally subtle and elastic, universally diffused and therefore present in all bodies, each highly repulsive to particles of its own kind, and attractive to those of an opposite nature. An unexcited substance possesses both fluids in an equal degree and in a state of combination; whereas any circumstance, such as friction, contact, or chemical action, which disunites the combined electricities, and thereby occasions the whole or part of a body to have more of one electricity than of the other, causes electric excitement. The repulsion exerted among the particles of each electricity to those of its own kind diminishes as the squares of the distance; and the mutual attraction of dissimilar electricities is regulated by the same law. This accounts for the inaction of unexcited contiguous bodies; for, though each electricity in each body repels that electricity

The theories of many of the most modern electricians look to the earth as only the receptacle of electricity, and to the sun as its source; and these theories are well summed up by Mr. Towers, and conjoined with a theory of his own repecting the conduction of the electric fluid through the points and vessels of plants, and the development of it by the decomposition of the sun's rays within the surface of the ground. "The earth," says he, "has been usually regarded as the reservoir and source of electricity,—and, in a qualified sense, it may, with propriety, be admitted so to be; but from many deep and important considerations, the mind can scarcely be satisfied that the earth is its sole and primary source. The form of our planet, its movements, and the various phenomena of attraction, gravitation, the vicissitudes of the seasons, and mutations of the weather, which are attendant on or result from these movements, seem to point it out as a recipient rather than as a generator,—as a body acted upon, rather than as one acting. To the sun, the centre of the system, we then must turn our attention, as to the great fountain of light and heat, the source of warmth and vital energy to the whole planetary system; to the animal as well as to the vegetable creation. * * The sun is either a solid body of luminous matter, or it is a body surrounded by a luminous atmosphere, containing in itself the elements or principles of light, magnetism, electricity, and heat. These elements reach the earth in rays or beams, which furnish direct evidence of being primarily composed of light and magnetism; they also contain electrizing and calorific principles, which, when brought into action, in an appropriate medium, produce and develope electricity and heat. The rays of the sun are also, under certain circumstances, refracted, reflected, and absorbed, but are never lost or extinguished, every particle being devoted and applied to the effectuation of a specific purpose. Among the chief and most important media of conduction and absorption are vegetable organized beings,—trees, shrubs, and herbs of all descriptions; and, by this process of absorption, the most beautiful phenomena are operated. Plants abound in pointed terminations, and contain a vascular system, composed of vessels and cells abounding with juices, which qualify them to become the recipients, and most ready and perfect conductors of electricity in any of its specific modifications. The solar rays thus absorbed during their passage through the vegetable organs, become themselves decomposed, while they effect many electro-chemical changes in those organs. Thus, the rays of light are laborated in vessels of the flowers and leaves, expressly adapted to the processes of separating and fixing the colouring principle. Other portions of the solar rays serve to stimulate the glandular and other vessels of the leaf, and to produce and propel the proper juices of the plant, which are then carried down through the returning vessels of the bark, or deposited in appropriate vessels of the cellular system. The whole of the unabsorbed or undecomposed rays pass downward to and through the roots, and thus constitute the descending current of solar vegetable electricity. Each individual specific process is performed by specific means; each particle of the rays is devoted to a specific purpose; and the combinations

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of the same kind in the other, with a force varying as the squares of the distance, attraction to exactly the same amount is exerted between the opposite electricities; and therefore as the two substances are reciprocally attracted and repelled in an equal degree, no effect whatever is apparent. When either of the electric fluids is in excess, its particles, by their repulsion, recede from each other as much as possible, and would escape from the excited body altogether, unless their passage were impeded by a non-conductor, that is, by a substance through which electricity is transmitted with difficulty. If, for instance, an excited substance be enveloped in dry air, the electricity, after reaching the surface of the body, will be retained by the air, and be accumulated at that surface; its effort to escape gives rise to pressure against the air, and is often productive of motion. This is familiarly shown by suspending near each other light substances, such as pieces of paper or pith-balls, and communicating electricity to them. If similarly electrified, the effort of the electric fluid to pass off in contrary directions causes the substances themselves to fly asunder; and when oppositely excited, they are drawn together by the effort which the fluids make to coalesce. Should the oppositely electrified be fixed instead of easily moveable, and their mutual attraction overcome the resistance of the air, the two fluids rush together with violence, causing heat, light, and noise in their passage, and the electric equilibrium is thereby instantly restored."—[Dr. E. Turner.]

and decompositions are effected by organs specifically adapted to the express purpose, and to no other; all in beautiful harmony, and all in accordance with the purposes of infinite wisdom. The surface of the earth is another grand medium of absorption. It receives the direct rays of the sun, one portion of which is reflected, another is absorbed, and becomes the great agent in effecting the electro-chemical processes which are carried on within the earth's surface, during and by which, the decomposition of water, the oxidation of metals, the formation of gaseous bodies, and other great natural phenomena, are uninterruptedly and for ever induced. It is, as I conceive, during the induction of these phenomena, that the electrizing process is begun and perfected; and that not only by the decomposition of the sun's rays themselves, but also by an energy which they exert upon matters within the earth's surface; and the results of this electrizing process are the separation of the principle of magnetism and the formation and development of heat and of electricity. The electricity so developed is distributed—if not through the mass, at least over the surface of the earth; and, in this sense, the earth may be considered as 'the reservoir both for the supply and absorption of electricity.' If the foregoing theory be correct, the phenomena which it contemplates approach those of the Voltaic electricity, though they are conducted on a scale infinitely more grand. Dr. Faraday's New Researches in Electricity tend to throw much light upon the subject of the immense volume of that fluid which is distributed throughout matter. But magnetism must not be overlooked. Is it identical with, or a modification of electricity? At all events, it evinces peculiar powers, which remind us of the plus and minus, vitreous and resinous qualities of the old electricians. Perhaps the day is not far remote when these two grand ethereal agents will be found to interpret the phenomena of positive and negative electricity." Mr. Towers afterwards argues, in the course of discussions on water, on heat, and on the atmosphere, that chemical action of every kind is effected by electric agency, and that, whenever electrical phenomena are discernible, chemical affinities are either regulated or induced; and he says, in particular, respecting the law of induction,—that law by which a body charged with electricity, though perfectly insulated by non-conducting substances from all bodies in its vicinity, yet tends to produce in these bodies a state of electrical excitement the opposite to its own,—"It is of the utmost consequence that this most influential law of induction should be clearly understood, and that the nature of the energy which it exerts, should constantly be kept in view; because on it, in all probability, depend not only many of the grandest phenomena of nature, but also those which result from the '*play of chemical* affinities,' and these are intimately connected with the processes of fermentation and solution, on which chiefly depend the preparation of vegetable aliment."

The power of electricity over vegetable organism, as affecting the germination of seeds and the growth of plants, is obviously a subject of great importance, abundantly worthy of the most patient investigation, and probably capable of being turned to vast practical account in the arts of culture. But it cannot yet be said to have, in any degree, become matter of science; and though it has, for a century past, and especially during the last three years, been anxiously and often and variously subjected to both scientific and practical inquiry, it continues to lie ensconced within the limits of theory and conflicting report. Though much has been written upon it and many experiments made, and though these are now worked up into a kind of system under the designation of electro-culture, we do not feel warranted either to promulge a theory of our own, or to adopt any one of the theories of others, or even to pronounce an opinion as to the aggregate result of the appeals which have been made to experiment. The whole subject is likely to receive great elucidation from the rapid progress of electro-chemical discovery; and future experiments will probably be undertaken with a far juster and more comprehensive reference to both the laws of electricity and the control of these over chemical affinities, than has yet been attempted, or than the present state of science can render possible. We shall, therefore, merely bring together a specimen of the theories which have been taught, and of the practical observations which have been made, and leave them to make their own impression on the minds of our readers.

The influence of electricity upon vegetation was prominently noticed exactly a century ago, by a citizen of Edinburgh of the name of Maimbry; and it has since engaged the attention of Jallabert, Sennabier, Bertholon, Duhamel, Nairne, Van Marum, Mushenbrock, Carmois, Ingenhouz, Cavallo, De Candolle, Davy, Pouiller, Ellis, Becquerel, Noad, Darwin, Dutrochet, and at least half a score of other eminent natural philosophers. Some have denied it,—but on different grounds, and generally in circumstances which throw suspicion upon the accuracy of their observations; and most have maintained it,—yet in very various ways, and upon conflicting or even antagonist theories. Cavallo says, "The most impartial, diversified, and conclusive experiments, have shown that electrization does neither promote nor retard vegetable life." Becquerel maintains that free electricity is badly conducted by the tissues of plants, and in so far as it affects them must do them injury; and that galvanic electricity, if it be energetic upon plants, cannot but destroy their tissues and alter the natural constitution of their juices. Sir Humphrey Davy says, "Electrical changes are constantly taking place in nature, on the surface of the earth, and in the atmosphere; but as yet the effects of this power in vegetation have not been correctly estimated. It has been shown by experiments made by means of the voltaic battery, (the instrument composed of zinc, copper, and water,) that compound bodies in general are capable of being decomposed by electrical powers, and it is probable, that the various electrical phenomena occurring in our system, must influence both the germination of seeds and the growth of plants. I found that corn sprouted much more rapidly in water positively electrified by the voltaic instrument than in water negatively electrified; and experiments made upon the atmosphere show that the clouds are usually negative; and as when a cloud is in one state of electricity the surface of the earth beneath is brought into the opposite state, it is probable that in common cases the surface of the earth is positive."—Dr. Darwin says, "A profitable application of electricity, to promote the growth of plants, is not yet discovered. It is nevertheless probable that, in dry seasons, the erection of numerous metallic points on the surface of the ground, but a few feet high, might, in the night-time, contribute to precipitate the dew, by facilitating the passage of electricity from the air into the earth; and that an erection of such points higher in the air, by means of wires wrapped round tall rods, or elevated on buildings, might precipitate showers from the higher parts of the atmosphere. Such points erected in gardens might promote a quicker vegetation of the plants in their vicinity, by supplying them more abundantly with the electric ether."—M. Dutrochet says, "The motion of fluids in plants, depends upon two currents of electricity, setting with very unequal force between the denser fluid of the tree and the lighter fluid of the soil; the more powerful current setting from the soil to the tree, and so producing absorption, by conveying aqueous particles into the roots through the vegetable membrane of the epidermis."—Mr. Towers, from whom we have already so largely quoted, says, in reference to M. Dutrochet's theory, "We trace the progress of true science in this novel and more than plausible hypothesis. It does not, it is true, say enough, but it says a great deal. M. Dutrochet subsequently abandoned his electrical theory. I regret this, and so did his friend, the late President, Mr. Knight. But the candour of this zealous and enlightened man must be admired. In our own country, another opinion has been advanced in a letter, addressed in November 1827 to the editor of a late periodical register. Its subject was, 'The relation between electricity and vegetation.' The writer advocated the theory, that vegetation is continually extracting electric influence from the atmosphere; that vegetables, as well from their structure, as by the nature of their juices, are peculiarly adapted to act with the greatest efficiency, in imbibing the effluvia; and that it is highly probable they are indebted to its influence for their vitality."

At a meeting of the Royal Institution in the early part of 1845, an important paper on the influence of electricity upon vegetation, was read by the Rev. E. Sidney. The attention of electricians, he stated, had been drawn to the subject so long back as 1746, when Mr. Maimbry, at Edinburgh, announced that electrified plants grew more rapidly and vigorously than those that were not so treated; about the same time the Abbe Nollet discovered that electrified seeds germinated with increased facility; and these observations were confirmed and extended by the experiments of Bertholon and Jallabert, the former of whom attributed very marked effects to the use of electrified water. The truth of these experiments was supported by some electricians, but denied by others, who, upon repeating them, could not perceive any effect produced on the electrified plants. Amongst the latter class stands the name of Sennabier; but on reading the account of how his experiments were performed, it is no longer surprising that he failed to perceive any effect from electricity, as he placed the seeds which were to be electrified inside an electrified vessel,—a situation in which, it is evident, they would not be exposed to the electric influence. After briefly adverting to the more recent observations of Davy, Pouillet, and others, Mr. Sidney drew attention to the recent progress of the subject, and the high interest it was at present exciting.—The first point which the lecturer insisted on was, that electricity appears to exercise a powerful influence on growing plants; in support of which, he quoted a number of experiments and observations, all tending to show, that plants, under the influence of electricity, grow with increased vigour, and more especially when negatively electrified. The manner in which drooping plants have been observed to revive, on the artificial application of electricity, was also noticed; and lastly, the effects which are found to be produced by thunder-storms were described. The rapid growth of plants during thunder-storms might, no doubt, in part be attributed to other causes; but, at the same time, it was a very fair inference, that the electric condition of the air had something to do with the phenomena, as such a conclusion was borne out by numerous experiments, on a small scale, made with artificial electricity. Electricity of low, like that of high tension, has been found to affect germinating seeds and growing plants in a remarkable manner. It was noticed by Davy, that seeds germinated more freely at the negative pole of the voltaic battery than at the positive; and since his time, numerous experiments have been made, all tending to prove, that voltaic electricity powerfully affects plants.—Mr. Sidney next drew attention to the facility with which fresh vegetable matters conduct electricity, in consequence of the good conducting power of the fluids which they contain. This was illustrated by placing a small blade of grass in contact with the conductor of a powerful electrical machine, when it was proved, that the whole of the electricity generated by the machine was quietly carried away by the blade of grass. It was also shown, that the pointed forms of the leaves and other parts of plants, combined with their good conducting power, fitted them most admirably to receive or disperse electricity; and hence electricians sometimes employed vegetable points in place of metallic ones for those purposes. To show this, a large Leyden jar was quickly and silently discharged, by bringing the pointed blades of grass near its outer surface, and the brass knob at the top. In consequence of the high electric powers of plants, as might be supposed, they exerted a marked effect on the electric condition of the atmosphere, so that when an electroscope indicated abundance of electricity in the free open air, it indicated none in the vicinity of a tree with pointed leaves. In illustration of the good conducting power of vegetable matter, Mr. Sidney stated that it was impossible to give an electric shock to a circle of people standing on a lawn, as the electricity invariably took the shorter and better conducting course through the grass; whilst there was no difficulty in giving a shock to any number of persons standing in a circle on gravel.—Thirdly; the apparent adaptation of the various parts of plants to different electrical uses, was pointed out. Thus, the first leaves of many plants are pointed and acute; others rounded or globose. The buds of most plants are pointed, or covered with a strong pubescence. Some plants, more especially those which grow rapidly, have an immense number of sharp points, or pointed hairs, whilst those which grow less rapidly, or are intended to meet the variations of the seasons, are less pointed, but often provided with dry thorns or prickles. As plants come into flower, they generally tend more to a globose form: the flower-buds are generally rounded, and the fruit or seed-vessels, are seldom provided with acute points. It may, therefore, possibly be the case, that though electricity is favourable to plants at one stage of their growth, it is hurtful to them at others; just as is well known to be the case with light, which is essential to them when full grown, but is hurtful to them in the embryo state.—The general phenomena of vegetation were then considered in relation to electrical agency. It would prove an interesting subject of inquiry, to examine in how far the rise of the sap in spring is influenced by electricity. It is certain, that in spring, and before the leaf-buds are opened, whilst they still retain their pointed form, the air is dry, and in the most fitting state for electrical effects. Mr. Sidney then adverted to the singular powers which plants have of precipitating moisture from the atmosphere, an effect which he suggested might possibly be of electric origin, and endeavoured to strengthen this view by a number of ingenious arguments; amongst others, the remarkable cases described by Mr. Weekes and other electricians, in which showers of rain were brought down by uninsulated kites. The lecturer next endeavoured to show that the forms and geographical distribution of certain species of plants indicate a relation to the electrical properties. Thus, for example, the numerous pine and fir trees which abound in high latitudes, present most admirable extensive discharging apparatus for receiving or dissipating electricity; and, supposing the preceding observations correct, such trees would exert most important and beneficial influence in equalizing the electric condition of the atmosphere, and tending to produce a greater uniformity of atmosphere.—Lastly; the subject was considered as a purely practical one; and the prospect which there exists of electricity being advantageously applied to stimulate or assist vegetation was inquired into. Mr. Sidney seemed to think it very questionable whether electricity could ever be usefully applied to the improvement of agriculture; but in horticulture (in forcing flowers and fruits) he thought there were prospects of a decided benefit; and, therefore, that this branch of the subject was well deserving a careful experimental investigation. Electricity, both common and voltaic, might probably be advantageously employed in assisting the germination of old and dry seeds; and likewise, applied with caution, in the culture of exotics and hothouse plants, its use might be productive of good results. The lecturer exhibited several plants which he had caused to grow in earth under the influence of a feeble current of voltaic electricity, generated by a plate of zinc and another of copper, connected together, buried in the soil beside the roots of the plants; and, in the case of plants of potato, cineraria, and mustard, which he exhibited, a very marked effect appeared to have been produced, as the galvanized plants were larger and much more vigorous than those without the plates. He stated that he had also produced a very good effect on pines, cress, and fuchsias, but had found plants of pelargoniums killed by the application of the zinc and copper plates.

During a number of years, electrical conductors in the form of paragreles or poles were numerously erected throughout vineyards, and in attachment to the vine-plants, in almost all parts of the south of France, and were believed to act beneficially in stimulating vegetation, invigorating the plants, and averting hail-showers; but, of late years, they have lost their reputation with the great bulk of the community, and incurred the derision of a portion of scientific cultivators. —The electricizing of seeds and of young ligneous plants has long been practised by experimental gardeners; and, in spite of much contempt, considerable ridicule, and general disesteem on the part of the rest of the community, it still continues to possess great interest with the class who are best able to pronounce upon its value. Electrified seeds of various kinds were found by M. Astier to run through the first stages of vegetation with more rapidity than non-electrified seeds; and electrified china-rose plants were found by the same philosopher to produce flowers sooner and in greater abundance than non-electrified china-rose plants.—An experimentalist noticed in the tracts of the Cavalier Amoretti, sowed turnip-seeds in two pots, electrified the plants of one of the pots as soon as they appeared through the ground, but did not electrify those of the other pot, repeated the electrification of the first at the end of 15 days, and found, in the course of about three weeks, that the electrified plants were 4 inches higher than the non-electrified. A fruit-tree in an orchard had electrical iron conductors placed among its branches; and it produced in proportion a much larger crop of fruit than any other tree in its vicinity. A branch of a Gleditschia triacanthus, two feet long and furnished with a single thorn, was found, in the experiments of Signor Brunodi Sazzi, to attract as much free electricity from the atmosphere as a brass point.

But all previous experiments were both few and paltry compared with thousands which, within the last three years, and particularly between the spring and autumn of 1845, were made in both the fields and the gardens of Great Britain. The doctrine of the invigorating and developing power of electricity upon plants, and particularly upon barley as well as other cereal grasses, was triumphantly tested and enthusiastically taught by Dr. Forster of Findrassie; and so great a sensation did it make throughout the kingdom as to rouse many hundreds of cultivators to put it, on their own fields or within their own gardens, to the test of experiment. In 1845, it was tried in the Horticultural Garden at Chiswick, in some other public gardens, and on about 700 acres in all parts of the United Kingdom. Dr. Forster's experience, as well as his theory and his instructions, had reference only to the free electricity of the atmosphere and to one particular method of applying it; but the experiments which his example prompted, though mainly conducted upon his own model, also tried various other methods with free electricity, and even in some instances dealt with voltaic or galvanic electricity.

Dr. Forster set up poles at a considerable distance from each other, and in mutual relation of due north and south; and he stretched thin iron wires along the top from pole to pole, and then conducted them down to a couple of inches within the soil, and led them round the circuit or limits of the plot which he had selected for his experiment. The plot was sown with barley, and was expected to drink in the electricity through the points of the plants from the wires. "It was electro-cultured," says he, "with poles four feet high. When the barley was six inches high, it was very decidedly of a darker green colour than the surrounding barley. On reaching a foot in height, it lost this deeper colour, as its points collected all the electricity within the reach of the suspended wires' power of attraction; and the colour was partially, but equally clearly restored to it, by two suspended wires, and more lofty poles being adjusted. * * As to the proper height of the poles, or rather of the lowest suspended wire, where more than one is employed, the rule is to have the lowest wire fully six to eight feet above the highest probable altitude of the vegetable under experiment, when at its full growth; and if more than one wire is required for wider or larger plots, there ought to be a space of three feet in elevation between them. The reasons for these proportions depend on the relative attractive powers for the electric fluid, that many electricians have proved to exist between the points of plants and points or edges of metals, the former being three to four times more powerful than the latter; and the preference given for one line of wires, arises from the convenience of being then enabled to harrow and plough without removing any of the arrangement, and of having far larger areas in one plot."

The general results of the experiments in 1845, in direct imitation of Dr. Forster's method, proved unfavourable; yet by no means, without such instances of decided success, or with such evidence in the failure cases of final appeal to the principles of electric science, as either to impugn the soundness of Dr. Forster's theory, or to quench the hope that atmospheric electricity may, in some more advanced state of scientific progress, or even in the course of two or three years, be made highly subservient to the purposes of agriculture. Some journalists and other public men, indeed, felt themselves justified, in the autumn of 1845, to pronounce all hopeful or rational experiment on the subject at an end. A writer in the Agricultural Gazette, for example, said, "The results of experiments in electro-culture are by this time generally ascertained. Our own, and all others of which we have heard, show that no influence is exerted on the growth of plants by an electro-conducting connexion between elevated and buried wires, arranged either as Dr. Forster has recommended, or according to other plans which have been tried. The word *electro-culture*, in fact, must, for the present, be considered a misnomer. There has been no want of electric disturbance this season in the atmosphere; hail and thunder-storms have been more than usually frequent; and we are, therefore, bound to believe that the experiments which have been tried are conclusive upon the subject. Their results leave everybody at liberty, just as before, to form their own opinions as to the influence of atmospheric electricity on the growth of plants; they only determine our ignorance of any means by which this influence can be increased or controlled." Mr. Coventry, too, the Secretary of the Agricultural Chemistry Association of Scotland,—who had cognizance of experiments by friends of his own in four of the best agricultural counties of the Scottish lowlands, and who himself tried one experiment with the additional provision of 12 or 14 sharp spikes upon his wires, and another with the encircling course of wire a few inches above the ground instead of beneath its surface,—even this eminently qualified judge regarded the whole affair in so desponding a light as to feel very doubtful whether he should ever be induced to put it again to the test. Yet some intelligent farmers and competent observers were quite gratified with such experiments as were conducted either by themselves or within the sphere of their observation; a few were so delighted with them as to become enthusiastic in the praise of electro-culture; some of the public journalists expressed, in the course of the summer, a conviction that the balance of experiments would turn out in favour of the new theory; and even some of the disappointed experimentalists were perspicacious enough to ascribe failures rather to deficient practice than to erroneous principle, and candid enough both to ascribe credit to the far-sightedness of the electro-culture doctrine, and to express a hope that it might prove a means of incalculable benefit to mankind. "What has hitherto been done on this subject," said a gentleman of the last of these classes, "is of small moment: the attempts have been merely trifling and theoretical. Dr. Forster has the sole merit of first suggesting a useful and economical application of this wonderful agency. In fact, the great objection to the success of his system is, that such a sudden advance in cultivation as this promises has never been made before, and seems almost contrary to the laws of nature."

One of the successful experiments with galvanic electricity in 1845 was conducted in the agricultural department of the gardens of the Royal Botanic Society of London. A plate of sheet copper two feet in length and nine inches in depth, and a plate of zinc of the same dimensions, were buried in the ground, about nine feet apart from each other, in an upright position, and facing the magnetic north and south; two copper wires were soldered to the upper corners of the plates, and extended from plate to plate at the height of about three inches above the surface of the ground; and thus a galvanic battery was formed, the moist earth completing the circuit. Within this parallelogram of ground were sown clover, sainfoin, lucerne, mangel-wurzel, and turnips; and within another parallelogram only 18 inches distant, and of precisely the same size and conditions except for being uninfluenced by galvanism, were sown an equal quantity of the same seeds. The clover and sainfoin of the galvanized plot were placed next the plates, and very extensively died out when mere plantlets; the lucerne was placed next, and also seriously failed; and even the turnips and the mangel-wurzel, were for some time considerably damaged;—and all appeared to receive injury from the presence of a greater degree of galvanic electricity than the early stages of their growth were able to bear. But the surviving turnips and mangel-wurzel, amounting to about five-sixths of the whole, speedily began to receive very visible benefit; and when compared, toward the end of autumn with those of the ungalvanized parallelogram, the turnips were found superior in the ratio of 55 to 11—or, but for an accident on the ungalvanized ground, 55 to 15—and the mangel-wurzel in the ratio of 29 to 20.

Mr. Coventry's unsuccessful experiments in electro-galvanic culture figure as prominently as his unsuccessful experiments in free electro-culture; and his report of them, both on its own account, and for the sake of some remarks which he appends to it, requires, in all justice to our general principles of impartiality, to be fully quoted. "I now," says he, "tried galvanism. After the method used by my friend Mr. Bain for his electric telegraph and clocks, I sunk a quantity of coke, two feet deep and six wide, and (at some forty yards distance) the same quantity of zinc, and connected them by a copper wire, which was insulated with glass, and kept from touching the ground. The weather, at first especially, was moist and favourable; but still I got no result of any value. This was disappointing—for the discoveries of Mr. Bain and Matteucci had shown that if any benefit attended the use of galvanism, it was at least of easy application. Indeed a whole country-side might be galvanized by running a long cordon of zinc at one end, and of coke at the other, when all between would be under the influence if these were connected by a wire. Matteucci's very singular experiments were made with a galvanic battery of little power. He used, as I found on looking into the Comptes Rendus for 1844, a single arrangement of Bunsen and rain-water. Whether the earth would be an equally good conductor of galvanism of high tension, as he had found it to be of low, is more, I believe, than is yet known; but, indeed, the results he arrived at were quite as unexpected and inexplicable as any yet to be tried can well be. But leaving this point in abeyance, and without pretending to determine anything in regard to the earth's conducting power for galvanism of high power, I thought at least of trying what effects the high power would have. It would at all events present the gases in a nascent state to the roots, with a variety of secondary actions. For this end, I took a battery of eight platinized silver plates, about four and a-half inches square, and sixteen amalgamated zinc plates, and having charged it with sulphuric acid and water in the proportion of one to nine, I inserted a plate of copper at the end of a small wooden trough, three feet long, full of earth, and a zinc plate at the other, and connected the former with the zinc pole of the battery, and the latter with the silver. I then sowed a quantity of garden mustard, and in another trough had the same quantity sown in similar earth; and as to depth and watering, the two were treated alike. The plants in both appeared, but in no respect was there any difference that I could discover. They were allowed to grow to some height, but still without any perceptible difference. This experiment I repeated afterwards with barley, and with the same result. To test the efficacy of electricity still further, I called in the aid of a second battery; and my last experiment was with barley grown under the influence of two Smee's batteries, but I am sorry to say that I got nothing even then to encourage me to make any more trials. The last plants are now dried, and any one may see them. If these experiments had been more successful, the subject would have been worth prosecuting; but I have no mind to go on. Perhaps I may resume it; but lest it should be otherwise, I will mention what I thought of trying, in case there may be others who may wish to take up the inquiry. There is, then, an experiment mentioned in Brande's Journal of Science, vol. iii. (New Series), p. 501; and in connexion with it there should be considered a very curious experiment of the late Mr. Barry, which is noticed by Professor Faraday in his Researches, p. 95, and in the article on Electricity, in the Encyclopædia Britannica, p. 632. Again, the efficacy of electricity in raising water in capillary tubes may suggest certain experiments with plants; and I may refer to Porret's experiments, mentioned by Dutrochet, vol. i. p. 70, and by Becquerel, vol. iv., p. 200, begging to remind the reader, that it is pure water only which can be so raised, and not a mixture of water with acids. There is also an important point to settle between Becquerel and Sir Humphrey Davy; the one maintaining that the negative pole favours germination, and the other that the positive; and both giving very plausible reasons, and very unhesitating statements. Lastly, Sir Humphrey Davy has given us a method, as everybody knows, by which either an acid or an alkali may be injected into plants with the aid of galvanism; and it would be important to know how far this admits of being done, and with what effects on succulent shrubs, forest trees, and fruit trees, and on the fruits also when formed. Where all this may lead, no one can tell; but looking to what the chemist has done in the last few years, we may well hold up our hands, and ask with Antonio, 'What impossible matter will he make easy next?'"—*Leithead on Electricity.—Davy.—Thomson.—Turner.—Franklin.—Darwin's Phytologia.—Bulletin De Sciences Agricoles.—Edinburgh Encyclopædia.—Gardener's Chronicle.—Magazine of Domestic Economy.—Agricultural Gazette.—Quarterly Journal of Agriculture.—Horticultural Mag.—Farmer's Monthly Miscellany.—Irish Farmers' Journal.—Gardeners' Gazette.—Towers' Gardener's Manuel.*

ELECTRO-CULTURE. See ELECTRICITY.

ELECTUARY. A medicinal pulpy mixture of vegetable or light earthy substances and honey or syrup. It has a near resemblance to a confection, and is designed to be a palatable form of exhibiting a disagreeably-tasted active medicine. See the article CONFECTION.

ELEMENT. A ponderable substance which cannot, by any known power or agency within the control of man, be decomposed or reduced into other substances. An element, in old popular philosophy, was either air, earth, water, or fire; and, even in modern popular language, it is any agency, whether simple or compound, in either weather or natural chemistry; but, in all accurate phraseology, it is a ponderable undecomposable substance,—some one of the simple ingredients of which compound physical substances consist,—and neither a force, an affinity, a compound power, nor a chemical imponderable. Elements are chemical simples; and if any substance hitherto esteemed an element shall be discovered to consist of two other substances, it will immediately cease to be regarded as an element, and will surrender its reputation as a simple to the substances which compose it. The list of elements has, in recent times, been greatly altered, and on the whole much enlarged, by the progress of chemical discovery; and it comprises at present 5 supporters of combustion, 6 inflammables or strong combustibles, 42 metals, and 2 substances of intermediate character between inflammables and metals. The supporters of combustion are oxygen, chlorine, iodine, bromine, and fluorine; the inflammables are hydrogen, nitrogen, carbon, sulphur, phosphorus, and selenium; the metals are iron, copper, silver, gold, platinum, zinc, mercury, cobalt, nickel, tin, lead, antimony, bismuth, manganese, arsenic, potassium, sodium, barium, strontium, calcium, magnesium, aluminum, zirconium, glucinum, yttrium, cadmium, lithium, vanadium, thorium, lantanium, palladium, rhodium, osmium, iridium, columbium, chromium, molybdenum, cerium, tellurium, tungsten, titanium, and uranium; and the substances of intermediate character between the inflammables and the metals are boron and silicon. These elements, so far as is known, constitute the whole of the ponderable matter of our world, whether solid, liquid, or aeriform; but some of them, such as fluorine and a considerable proportion of the metals, are exceedingly scarce; some, such as calcium, magnesium, potassium, sodium, aluminum, and silicon, though aggregately abundant, occur chiefly as bases of abundant earths; very few are ever naturally found in an uncombined condition; and several of the most abundant, such as the all-pervading oxygen and the almost all-pervading hydrogen, occur in an incalculable number and variety of combinations. All the enormous proportion of vegetable matter, whether living or dead, which is capable of being dissipated by combustion or eremacausis, or all except the small proportion which thorough combustion leaves in the form of ashes, consists of merely four elements,—oxygen, hydrogen, carbon, and nitrogen; and almost an equally enormous proportion of the mineral constituents of soils, subsoils, and surface rocks, consists of six elements,—oxygen, hydrogen, aluminum, silicon, calcium, and magnesium.

ELEMENTARY ORGANS. The microscopic, transparent, thin-sided, membranous sacs, out of which all the visible organs of a plant are formed. Those which have a spheroidal form are the most strictly elementary, or the least altered by compressing, disturbing, or displacing forces; and so many as 5,000 of them have sometimes been computed to lie within the space of half a square inch. But all, whether spheroidal, or of other forms, are very various in size and mutual disposition according to the particular part of the plant in which they lie, or to the particular function which they form. Such as have a cubical shape constitute the whole substance of cryptogams and the cellular tissue of phænogams; and such as have a tubular or cylindrical form constitute the ducts, spiral vessels, and other conducting tubes of the vascular tissue of phænogams.

But the rudimental or embryo parts of plants, also, are sometimes called elementary organs. "If," says Keith, "the embryo on its escape from the seed and conversion into a plant, as effected by the process of germination, is taken and minutely inspected, it will be found to consist of a root, a leaf or leaves, and an incipient stem, developed in consecutive order. Also, if the plant is taken and dissected at this period of its growth, it will be found to be composed merely of an epidermis enveloping a soft and pulpy substance that forms the mass of the individual; or it may be furnished besides with a central or longitudinal fibre, or with bundles of interspersed tubes or fibres, pervading all its parts and giving tenacity to the whole. The above organs are to be regarded as elementary."

ELEMI. A fragrant, aromatic, medicinal gum. It is imported from various parts of the world, and is believed to be the production of several kinds of trees. The elemi of the West Indies and of continental America is supposed to be the production of *Amyris elemifera* or *Amyris Plumieri*, an evergreen tree of the terebinth order, introduced to the hothouses of Britain about 25 years ago; that of the East Indies is supposed to be the production of *Amyris zeylanica*, an unintroduced species of the terebinth order; and that of Africa, sometimes called *Elemi verum*, is supposed to be the production of a species of the order and genus oleaster. Elemi is semitransparent, pale yellow, fragrant, slightly bitter, brittle without, tenacious within, and very fusible. It has stimulating properties, but is used chiefly for making a mild digestive ointment, which is ordered, by the pharmacopœias of both London and Dublin, under the name of elemi ointment.

ELEUSINE. A genus of grasses, of the chloris tribe. The Coracana species, *E. coracana*, was introduced to Britain from India in the early part of last century. It is an annual, of about 2 or 2½ feet in height, and possesses considerable agricultural value in its native country. Three other annual Indian species have been raised from imported seeds by British botanists; and about half a dozen additional species are known.

ELEUTERIA. See Croton.

ELIOCHARIS. See Spike-Rush.

ELL. A measure which obtains, under different denominations, in most countries, whereby cloths, stuffs, linens, silks, &c., are usually measured. The ell English is 5 quarters, or 45 inches; the ell Flemish, 3 quarters, or 27 inches. In Scotland, an ell contains 37 2-10 inches English.

ELM, or Elm-Tree,—botanically *Ulmus*. A genus of forest trees, forming the type of the order Ulmaceæ. This order is well represented by the common English field elm-tree; and yet is very closely allied to the nettle order,—differing from them, rather in a few technical peculiarities, than in any strictly natural character. It comprises the genera ulmus, celtis, and planera; and has within Great Britain 6 or 7 tender species, and between 30 and 40 hardy species.

The genus ulmus has bisexual flowers,—a coloured, persistent, bell-shaped, and four or five-toothed calyx,—from three to six stamens,—and a broad, membranously-margined suborbicular fruit. A few of its plants are shrubs; two kinds are evergreens; all are more or less ornamental in either the shrubbery, the hedge-row, the park, or the forest; and the greater number are tall, majestic, deciduous timber-trees. Linnæus enumerates only three species,—*Ulmus campestris*, with leaves double-sawed, and unequal at the base; *Ulmus Americana*, with leaves equally sawed, and unequal at the base; and *Ulmus pumila*, with leaves equally sawed, and equal at the base. Miller breaks up the first of these species of Linnæus into six species,—the common rough or broad-leaved wych elm, *Ulmus campestris*, with oblong acute-pointed leaves, doubly sawed in their edges, and unequal at their base; the wych hazel or very broad-leaved elm, *Ulmus scaber*, with oblong oval and unequally sawed leaves, and with leafy empalements to the flowers; the small-leaved or English elm, *Ulmus sativa*, with oval acute-pointed leaves, doubly sawed in their edges, and unequal at their base; the smooth-leaved wych elm, *Ulmus glaber*, with oval smooth leaves, sharply sawed on their edges; the Dutch elm, *Ulmus Hollandica*, with oval acute-pointed, rough, unequally sawed leaves, and with fungous bark; and the upright or smooth narrow-leaved elm, *Ulmus minor*, with oblong, acute-pointed, smooth, doubly sawed leaves. Hanbury deals with the *Ulmus campestris* of Linnæus in nearly the same manner as Miller, but breaks it up into seven instead of six sorts. Marshall selects two extreme kinds of cultivated elm,—the coarse-leaved, chestnut-leaved, broad-leaved, wych, or north-country, and the fine-leaved, hazel-leaved, narrow-leaved, or south-country; and, while dismissing all the other sorts as intermediate varieties, he drops a remark which accounts for the unusual course we are taking with the present article. "The fact is," says he, "no genus of plants whatever is more incomprehensible to the botanist than the Ulmus; for although we see among the cultivated elms of this country individuals as different from each other as are some individuals of distinct genera, yet every man who has attended closely to the several kinds of elms growing in different parts of the kingdom, must have observed such a chain of intermediate kinds as renders classification extremely difficult, and must frequently have met with an individual which he was puzzled to find a name for. Linnæus no doubt having experienced this, lumped the whole mass of cultivated elms in one species,—the *Ulmus campestris.*"

Sir James Smith distributes the native elms of Britain into five species,—the common small-leaved or English field elm, *Ulmus campestris*, with hard, tough, and very valuable wood, and occurring principally in the southern parts of England; the common cork-barked elm, *Ulmus suberosa*, taller and more spreading than the preceding, but with far less valuable wood, and with fine, dense, deeply fissured corky bark; the Dutch cork-barked elm, *Ulmus major*, with wide-spread and drooping branches, ragged corky bark, and almost totally useless wood; the broad-leaved Scotch elm or wych hazel, *Ulmus montana*, with large trunk, spreading branches, rapid habit of growth, smooth bark, and large, conspicuous, hop-like fruit; and the smooth-leaved or wych elm, *Ulmus glabra*, with tall stem, elegant and imposing outline, spreading and somewhat drooping branches, smooth and blackish bark, and smaller leaves than any of the other species except the common small-leaved. Loudon classifies the British elms into the same species as Sir James Smith, with an additional one, the spreading-flowered, *Ulmus effusa*, of about the same height as the wych elms; and he enumerates 9 timber-tree varieties and 11 ornamental or curious varieties of *Ulmus campestris*,—6 varieties of *Ulmus suberosa*,—7 timber-tree varieties and 3 ornamental or curious varieties of *Ulmus montana*,—and 7 timber-tree varieties and 3 ornamental or curious varieties of *Ulmus glabra.* Loudon also enumerates 13 introduced species,—the white American, the winged, the scabrous, and the deep-yellow, hardy deciduous timber trees from North America; the white Hungarian, a hardy deciduous timber tree from Hungary; the shrubby, the low, the small-leaved, the little-leaved, and the dwarf, ornamental deciduous shrubs from Siberia and continental Europe; and the Chinese, and the entire-leaved, tender ornamental evergreens, the former a small shrub from China, and the latter a tree of the same height as the wych elm from the East Indies. The most abundant and valuable of all the species are the common small-leaved and the wych, often called emphatically the English and the Scotch elms; and these may be selected as the subject of a little further notice.

The common English elm, the *Ulmus campestris* of Smith and Loudon, usually attains a height of about 80 feet, and a correspondingly great bulk and massive appearance. Though often trimmed up to a mere maypole, or at best with a close aspiring crown of foliage, yet, when planted singly and suffered to form its own head, it attains an outline equal to that of a beech or a lime-tree. It frequently and not unjustly ranks, in the estimation of the foresters and planters of England, with the oak and the ash; it probably comes next these two noble trees in combined picturesqueness and utility; and it far excels them in the two properties—so important for the formation of forest shelter—of having a comparatively rapid habit of growth, and of bearing to be transplanted when of comparatively great size. Its branches are more divided, and run shorter lengths, and have less delicate bark than those of the wych elm; its tendency of growth is upright, so as to afford great facility for the fashionable but untasteful practice of training up the stem to a great height of gaunt and naked trunk; and its leaves have a somewhat circular outline, with a narrow point projecting from their periphery, and are comparatively thin, delicate, supple, and transparent, yet present great diversities of character in the different varieties of the species, and sometimes considerable diversities upon even an individual plant. This tree abounds in the south of England, peoples multitudes of hedge-rows, and is in great request, particularly in Norfolk and around London, for its timber; yet, though both plentiful and reputedly indigenous, it is a very doubtful native, and was probably introduced from continental Europe at no very remote period. It possesses less hardiness than almost any of our unquestionable indigens, and seldom matures its fruit in our climate, but propagates itself by suckers; yet, in a district so near to us as the vicinity of Paris it appears to feel quite at home, and easily, regularly, and in great quantities ripens its fruit. Many noble and venerable specimens of it occur in the Vale of Gloucester; and an individual of it between Cheltenham and Tewkesbury is mentioned by Marshall as, in 1783, having a trunk of ten feet high before throwing out large tree-like branches, and as measuring at its smallest girth exactly 16 feet. The timber of this species competes for fame with that of the wych elm; and in aggregate of utility, is perhaps superior.

Though excelled by oak in durability, by ash in toughness, and by beech in closeness of texture and cleanness of grain, it possesses a high degree of both hardness and toughness, is less liable to split than almost any other timber, and offers a powerful resistance to the decomposing power of water; and it has therefore been long in request for keels of ships, naves of carriage-wheels, pumps, casks, water-pipes, mill-wheels, foundation-piles, and wet-planking. Its leaves are eaten by cattle, sheep, and hogs; and its bark figures in the authorized materia medica of London and Dublin, as an agent of similar character to sarsaparilla, as a diuretic, and as a remedy for sore-throat, ichthyosis, and herpetic eruptions.—The timber-tree varieties of this species enumerated by Loudon are the common, the broad-leaved, the white, the acute-leaved, the upright, the green, the Cornish, the Jersey, and the twisted; and the ornamental or curious varieties are the white-variegated-leaved, the birch-leaved, the twiggy, the small-leaved, the flat-leaved, the Chinese, the cuculate-leaved, the concave-leaved, the yellow-variegated-leaved, the viscid, and the dwarf. All the timber-tree varieties are usually propagated by layering, and most of the ornamental varieties by grafting.

The wych elm or Scotch elm, *Ulmus montana*, is both the hardiest and the most picturesque of the elms, an undoubted native, and the only one of our reputedly indigenous species which seeds freely, and admits of ready and regular propagation from seeds. Its outline is bold and strongly marked, nearly resembles that of the oak, and is diversified, rugged, imposing, and romantic. "For our part," says Sir Thomas Dick Lauder, "we consider the wych, or Scottish elm, is one of the most beautiful trees in our British sylva. The trunk is so bold and picturesque in form, covered as it frequently is with huge excrescences,—the limbs and branches are so free and graceful in their growth,—and the foliage is so rich, without being heavy or clumpy as a whole,—and the head is generally so finely massed, and yet so well broken, as to render it one of the noblest of park trees; and when it grows wildly amid the rocky scenery of its native Scotland, there is no tree which assumes so great or so pleasing a variety of character." Its branches are clean, straight, and slender; its habit of growth, in most varieties, is rugged and rambling,—and in some, is drooping or pendulous; its bark is silvery; and its leaves are nearly oval, with an obtuse lance-like point, and have a gross, rigid membrane, and strong, close-set, somewhat parallel nerves,—yet they greatly vary, as to both size and other characters, in the different varieties. Most sorts of it, when attempted to be trained up with a tall straight stem, acquiring a nodding head with a posture like that of the panicle of oats; and the pendulous sorts, even when grown as standards and left wholly to themselves, acquire the form of huge drooping umbrellas, and form a kind of vast natural arbours. The uses of this species, particularly of its timber, are similar to those of the common English elm; but, in addition, young plants of it, not more than a foot in height, serve excellently to be intermixed with quickthorns in forming hedges. A wych elm in Sir Walter Bagot's park in Staffordshire is stated by Evelyn to have measured 17 feet in diameter at the base, to have had a height of 120 feet, and to have possessed an estimated weight of 97 tons.—The timber-tree varieties of this species enumerated by Loudon are the common, the rough-leaved, the greater, the less, the Cevennes, the Irish black, and the southern; and the ornamental or curious varieties, are the pendulous, the fastigiate, and the curled-leaved. But only the common kind is propagated from seeds; and all the other varieties are propagated by grafting.

"We agree with Sir Henry Stewart," says Mr. Watson, "that 'no man who knows anything of wood, will put down the sycamore, the lime, or the wild cherry, for example, on a clayey soil. Neither will he put the oak or the elm on a light sand or gravel, but on the contrary, on the deepest and loamiest land he can find, and in the case of the oak, even with a clay bottom.' No doubt but Sir Henry is here speaking of landscape gardening, where trees may be raised to the greatest size and effect; but we have seen trees of both kinds grow to useful purposes, on light gravelly soils, although not best adapted to their nature. We are of opinion that the elm points out its own natural soil and situation. But it may be observed, that on inferior soils, such as clays or moorlands, it never rises to any magnitude so as to become valuable timber. In any extensive forest plantation, it seldom happens but that some patches of ground congenial to the elm may be found, particularly if streams run through the plantation; and a few elms may there be planted to great advantage, not only for profit, but to give a picturesque view to the surrounding scenery." — *Gilpin's Forest Scenery.* — *Marshall on Planting.*—*Watson's Forester's Manual.*—*Strutt's Sylva Britannica.*—*Nicol's Planter's Calendar.*—*Miller's Gardener's Dictionary.*—*Loudon's Works.*—*Knowledge Society's Ornamental Planting.*—*Museum Rusticum.*—*Society of Gentlemen's Complete Farmer.*

ELSHOLTZIA. See Chryseis. Only three species of the labiate elsholtzia have been introduced to Britain, and one of these is a hardy, ornamental, pink-flowered annual, of about 20 inches in height.

ELYMUS,—popularly *Lyme-grass.* A genus of hardy grasses, of the barley tribe. Its spike is either simple or compound; each tooth of its rachis has two or three spikelets, each containing three or more fertile florets; and its lower paleæ are entire and awned. Two species grow indigenously in England; one species is a native of both England and Scotland; about 20 species have been introduced from foreign countries, principally Siberia and North America; and two or three additional species are known to botanists. Only seven, however—the jointed, the European, the sandy, the Siberian, the rough, the Philadelphian, and the striated—possess sufficient interest to challenge special notice.

The jointed, knee-jointed, or pendulous species, *E. geniculatus*, grows wild on the sea-shores of England. Its root is perennial, strong, and creeping, and acts exhaustingly upon the soil; its culm is winged and usually about 4 feet high; its foliage is coarse and tough; and its spike is pendulous and appears in July. It contains a larger proportion of nutritive matter than the hard and inedible bents, but a much smaller proportion than any of the true agricultural grasses; and it possesses value chiefly in its eminent power of binding the loose, drift sands of the coast, and preventing the encroachments of the sea. In the Woburn experiments, it was grown upon sandy loam; and, at the time of flowering, it yielded produce at the rate of 20,418 lbs. per acre.

The European species, *E. europæus*, grows wild in the woods, thickets, and hedges of the chalk districts of England. Its root is perennial; its culm is erect, striated, and about a yard high; its foliage has a softly and agreeably green colour; and its spikes appear in June and July. It is too coarse and innutritious to be regarded as more than a mere weed; and, at best, it serves only to assist the ground verdure and the natural manuring of woodlands.

The sandy, upright, sea, or star-bent species, *E. arenarius*, grows naturally on the sea-coasts of England and Scotland. Its root is perennial, strong, and powerfully creeping, and has an exhausting effect upon the soil; its culm is quite erect, and about 4 feet high; its leaves have a glaucous green colour, and are partly rolled in at the edges; its spike is simple, erect, and close, and appears from April till June; its spikelets are generally in pairs and three-flowered; and its florets are pubescent, awnless, and not quite so long as the fringed glumes. This species resolves one-third of all its soluble matter into sugar, and has therefore been called the sugar-cane of Britain; yet, in consequence of its hardness and excessive coarseness, it is not eaten by any of the depasturing animals of the farm. One economical use of it is to cut its hay into chaff and mix it with corn or with common hay for the cattle of the farm-yard; and another and perhaps more important one is to grow it along with the jointed species and the *Ammophila arundinacea*, for binding the drift sand of the coast, and resisting the aggression of the sea.

The Siberian species, *E. sibiricus*, is a native of Siberia, and was introduced thence to Britain in 1758. Its root is fibrous and perennial; its culm has a height of from 4 to 7 feet, and, whether green or dry, is much relished by cattle; its leaves are long, broad, soft, tender, and numerous,—they cover the stem almost from base to summit,—and, both as herbage and as hay, are readily eaten by cattle; its spike appears in June and July, hangs down, and is compound at or below the middle; its spikelets are usually single on the lateral branches, and double or treble on the central spike; its florets are commonly in fives, and longer than the slightly awned glumes; and its lower paleæ are terminated by awns of nearly twice their own length. Though classed as a perennial, it has habits of duration very similar to those of the cultivated rye grasses; and, regarded as an agricultural plant, it seems much better adapted to the alternate husbandry than to perennial pasture. The soil most suitable for it is a porous, dryish loam. In the Woburn experiments, it was grown upon rich sandy soil; and, at the time of flowering, it yielded per acre 16,335 lbs. of green produce, 5,717 lbs. of dry produce, and 574 lbs. of nutritive matter.

The rough or porcupine species, *E. hystrix*, called by Willdenow *Asperella hystrix*, is a native of the Crimea, and was introduced thence to Britain in 1770. Its root is perennial; its culm has usually a height of about two feet; its leaves are broad, thin, light green, and harsh; and its spikes appear in June and July, and ripen their seeds in the course of about a month. In the Woburn experiments, it was grown upon rich silicious sandy loam; and, at the time of flowering, it yielded per acre 27,225 lbs. of green produce, about half that weight of dry produce, and 1,063 lbs. of nutritive matter. It contains an excess of bitter extractive, and is deficient in sweet nutrient elements. The whole plant has a curious appearance; but is more interesting to the botanist than valuable to the farmer.

The Philadelphian species, *E. philadelphicus*, is a native of North America, and was introduced thence to Britain in 1790. Its root is perennial; its culm is usually about 4 feet high; its foliage is large and rank, and appears rather early in spring; and its spikes appear in July and August, and mature their seeds in the course of about three weeks. In the Woburn experiments, it was grown upon a clayey loam, incumbent on a retentive subsoil; and, at the time of flowering, it yielded per acre 30,628 lbs. of green produce, 15,314 lbs. of dry produce, and 2,033 lbs. of nutritive matter. It is too rank to be fit for pasture; but it serves well to be grown on coarse land, and used either for soiling, or in cut and chaffy intermixture with corn or with meadow hay. The proportion of the nutritive matter of its hay, compared with that of the hay of the best meadow or sown grasses, indeed, is only as 34 to 57; but an acre of coarse half-waste land which would not produce more than about 25 cwts. of hay of these grasses, produces about 6 tons of the hay of Philadelphian lyme-grass.

The striated species, *E. striatus*, is a native of

North America, and was introduced thence to Britain in 1790. Its root is perennial; its culm is generally about a yard high; its foliage is later in appearing than that of the Philadelphian species; and its spike comes out in July, and matures its seeds in August. Its nutritive value is inferior to that of the Philadelphian species, in the proportion of about 16 to 17. In the Woburn experiments, it was grown upon clayey loam; and, at the time of flowering, it yielded per acre 20,418 lbs. of green produce, 8,933 lbs. of dry produce, and 1,276 lbs. of nutritive matter.

ELYTRA. The scaly or horny wing-covers or anterior wings of beetles. They are opaque plates, destitute of nerves, and internally lined with a thin membrane. In a few species, they are somewhat soft; in a considerable number, they are so flexible or elastic as to yield to pressure; but in the great majority, they are hard and horny; and in some, they are so firm and dense as not to be easily pierced with a pin. They exceedingly vary, in the different species, as to at once size, shape, clothing, and colour. In most species, they usually cover the wings; in nearly all, whenever the insects are not flying, they are carried in a horizontal position on the back; and, in a few which have no wings, they are firmly soldered together, and serve for the defence of the abdomen.

EMASCULATION. The rendering of a male animal masculinely impotent. See the article Castration. But the term emasculation has also been recently used to designate such an operation upon a vine as shall occasion it to produce grapes without pips.

EMBANKMENT. A mound, bulwark, or any similar work, for either reclaiming or defending land from the inundation or encroachment of water. Some embankments serve for the acquisition of new land from the dominion of the tides or of spreading rivers; some for the protection of old land from the abrasion of the sea, the overflowings of lakes, or the floodings and freshets of streams; and some for the constant and regular maintenance of the balance between drainage and irrigation in reclaimed fens and low-lying meadows. The embankments for the reclamation and protection of the vast low grounds of Holland, have long been a stupendous model of this class of works, and an evidence of what human industry, when roused into energy and maintained in activity by interest and self-protection, is capable of achieving. The embankments round the sea-board fens of England, too, particularly those of Lincolnshire, Cambridgeshire, Bedfordshire, Norfolk, Yorkshire, Somersetshire, and Cheshire, are works of great enterprise and magnitude, and combine with a grand and ramified system of superficial drainage, to maintain in a state of healthful and valuable use for man several hundreds of thousands of rich acres, which would otherwise be regions of desert and pestilential morass. See the article Draining. But the proper methods of constructing such extensive works have been little modified by modern science, and do not require to be particularly stated; and we shall, therefore, merely refer to some of the best sources of information on the subject of embankments, and then subjoin a few general hints respecting such comparatively limited embankments as are required on ordinary estates or on single farms.

Some observations on embankments by Mr. Beatson of the Royal Engineers, and interesting accounts of embankments at Marasion marsh in Cornwall and at Pembrey in Caernarvonshire, occur in the 2d vol. of the Communications to the Board of Agriculture. Accounts of embankments on the Rhine, in Cumberland, in Wales, in the vicinity of Plymouth, and in another district, occur in the 6th vol. of these communications. Accounts of great embankments of carse lands in Nairnshire, in Galloway, and on the Firth of Forth, occur in the 3d vol. of the Farmer's Magazine. An account of a large embankment in the great valley of the Forth and Clyde Canal occurs in the 18th vol. of the Old Statistical Account of Scotland. A short account of embankments on the Spey at Gordon Castle, occurs in Souter's Survey of Banffshire. An account of an embankment of 1,300 acres of meadow land occurs in the Report of Gloucestershire. Three essays on embankments—with appended remarks, which we shall chiefly follow in the subsequent paragraphs of this article—occur in the 8th vol. of the Transactions of the Highland Society. Some excellent general observations on embankments occur in Rham's Dictionary of the Farm, in the Penny Cyclopædia, in Sir John Sinclair's Code of Agriculture, in the 1st vol. of the Useful Knowledge Society's Treatise on British Husbandry, in the Supplement of the Encyclopædia Britannica, and in the 30th No. of the Quarterly Journal of Agriculture. And consecutive views of the whole subject, in reference to embankments of all sizes, of all kinds, and of all adaptations, occur on pp. 614—676 of the 3d vol. of Sir John Sinclair's General Report of Scotland,—on pp. 120—148 of Stephens' Practical Irrigator and Drainer, and on pp. 157—213 of Johnstone's Theory and Practice of Draining and Embankments.

Some of the many embankments desiderated or proposed by tenants would cost far more than their probable advantages would be worth, and therefore cannot be expected to commend themselves to the approbation of the landlord; but many, perhaps far the majority, would materially increase the permanent value of the property, and require only to be clearly described and accurately estimated in order to secure the favour even of a landlord who is generally apathetic and miserly on the subject of improvements. In every instance of desired embankment, the facilities for forming it, the situation and materials for it, the entire expenses of its erection, and the probable value of the advantages which it will entail, ought with all possible nicety to be ascertained; and only such an embankment should be thought of as most nearly suits the particular circumstances,—whether a cheap and slender work for encountering a feeble force of encroachment, or a costly and most massive work for offering the mightiest resistance.

If the embankment is wanted merely to resist the ordinary and constant erosion of a river upon its banks, it may be formed simply by throwing down, at the places most liable to injury, a quantity of rough and not very large stones, leaving them to find a bed for themselves, and to form by their own subsidence a slope to the margin of the river's channel, either from the top of the bank, or from a line a little above the ordinary level of the water. But the whole deposit ought to be made strictly parallel with the course of the stream; for if run out into moles and jetties, as some authors recommend, with the design of diverting the current from the parts where mischievous erosion is apprehended, it will throw the water with new and violent force against some part of the opposite bank, and only remedy a certain amount of evil on the one side by inflicting a corresponding amount upon the other. When stones cannot be obtained, a series of wooden piles may be driven in along the margin of the stream, and warped with branches of shrubs or trees, and the spaces behind filled up with furze or any similar material. When only small stones can be obtained, and the erosive force of the current is comparatively great, wooden piles or cradles may be so driven in as to act as retainers of a packing of small stones. The cost of a simple embankment in any of these three methods, will depend mainly on the nearness and plenteousness of the materials, and may, in any particular instance, be very easily calculated.

If the embankment is wanted merely to resist occasional floods, it may, in probably every instance, be formed solely of the earthy materials of the adjacent land. But every embanking mound of such materials must have a very broad base, and must greatly slope from top to bottom. The narrowest base on which loose earths will lie so as to form a compact and unyielding mound, has a proportion of from 18 to 24 inches horizontal to every 12 inches of height. "If the slope can be laid or built up with strong turf, it could be made to stand much steeper than this, as in the case of turf dykes. But, besides that these are not very permanent, unless considerably sloped, the embankment must have strength to hold in the waters of the rivers during floods; and this can only be obtained by founding it on a broad basis, and sloping the sides in proportion, otherwise it would soon be overset by the powerful action of the fluid standing against it, and pressing it externally with a pressure everywhere proportional to the square of its depth. A considerable breadth is also required to prevent the water from rushing through the bank, particularly if it be of a sandy or gravelly nature, unless a puddle-wall of clay be carried up through the heart of it, which, however, for occasional inundations, is hardly necessary. With a gentle slope, also, the sides of the bank will carry crops of excellent grass, and thus the ground will be turned to account. In every view, then, the sloping of the sides of the embankment is of advantage; and however more, it should never be less, than what has been stated, unless other circumstances should require it. In the view, for example, of forming the landslope into a fence, it may then be reduced, with the aid of turf, to a slope of one half foot horizontal to one perpendicular, but not less. But if stuff can be easily had, it would be still better to keep up the slope, and erect some fence on the top of the bank. Towards the river, the slope of the bank has still other advantages. As the level of the water rises in floods, it enables it to spread out into a wider and wider channel, and thus checks the farther rise of the inundation as well as the increasing rapidity of the current; in which view, also, the embankment is often carried a considerable way off the natural channel of the river. When the current of the river, also, is rapid, the side of the embankment is liable to be torn up, and the loose materials which compose it washed away in the stream. Nothing serves to withstand this action so effectually as the sloping-plane, which, presenting a larger extent of surface to the waters, diminishes in proportion to the intensity of their action, while the flatness of the bank, promoting the vegetation of the grass, a hard and firm surface is soon formed, which resists completely the violence of the stream. On these accounts, the slope towards the river, however much more, should seldom be less than three or four feet horizontal, to one perpendicular." The top of the embankment ought to be two or three feet higher than the level of the highest known inundation; and the cost of forming it will vary in different circumstances from 2d. to 6d. per cubic yard, and may easily be estimated, in any particular case, by calculating the number of required cubic yards.

If the embankment is wanted to resist the action of the tidal waves, either in a bay or upon the open shore, especially if it must confront that action not only during the height of spring tides, but down to a portion also of neap tides, it cannot be formed, in any very firm or tolerably durable manner, of other materials or with lighter work than those of a massive stone bulwark. The daily action of the sea-water, and especially the occasional tempestuous action of the billows, in such circumstances, would speedily destroy the vegetation and tear up the surface of the best possible turf-clad mound. "The stone bulwark should be built along the bank, in a direction sloping not less than 1½ or 2 to 1 from the surface of the ground up to the level of high water of spring tides, from whence the remaining height may be made up with turf sloping 3 or 4 to 1. The stones of the bulwark should be as large as possible, well built, and as closely jointed as practicable. Immediately behind, the space should be filled up with smaller stones thrown in at random, such as cannot be drawn by the reflux of the waves through the joints of the larger ones. Behind these, again, the space should be filled with still smaller ones or gravel, and then with turf, furze, or other material, to prevent the sand or earth of the embankment from being washed away by the reaction of the waters. These bulwarks become rather expensive for ordinary embankments, particularly where they require raising to any height. Along the shores near Newhaven and Leith, for example, which are protected in this manner by bulwarks extending down nearly to the level of half tide, and where the stones are found on the adjacent beach, the expense runs not less than from 4s. to 6s. per square yard, reckoned along the surface of the bulwark, so that, if this, for instance, be only 12 feet from top to bottom, every linear yard will cost 15s., besides the expense of the embankment itself. In every case, the expense will depend on the extent of surface in the bulwark, and the price per yard of collecting and building the stones. Where stones, however, cannot be had, or where the expense is too great, other means have been resorted to for defending the bank, such as are much used in Holland, and in England along the coast of Lincolnshire, and other places. These consist of reeds or straw kept down by planks or pieces of wood pinned into the bank; faggots, wicker-hurdles, nets of straw-ropes, &c., laid along the surface of the bank, or wicker hedges raised along the bottom, or in parallel rows along the slope of the bank. These plans require unremitting attention to repair the openings or breaks which are constantly occurring in the banks; and, for this purpose, they are regularly watched throughout the year."

EMBROCATION. Any medicinal preparation or compound, in a liquid state, and of a warm, heating, rubefacient nature, for external application to man or the domestic animals by friction, with the design of relieving numbness, sprains, chronic pains, or inflammatory action. The principal embrocations in use for the horse are employed for the relief of bruises, saddle-galls, strains in the back sinews, and inflammation of the bowels; and they consist principally of such ingredients as camphor, oil of turpentine, muriate or water of ammonia, spirit of wine, and oil of origanum, —and also, when active counter-irritants are required, of flour of mustard and tincture of cantharides.

EMBRYOTOMY. The cutting of a young or embryo animal from the womb of its mother. Either when the embryo itself has some malformation which prevents parturition, or when the expulsive power of the mother's womb becomes prematurely exhausted, and cannot by the use of any safe stimulus be roused again into action, the operation of embryotomy becomes indispensable for saving the mother's life. Cases of necessity for it in the cow and the mare are not altogether rare; and, in as far as the calf or the foal is concerned, are usually occasioned by unnatural enlargement of some of its parts,—particularly its head. The operation is performed by passing up the hand, with a curved, blunt-pointed, strong bistoury, or with a knife similar to the pruning-knife of a gardener, but more curved in the blade, and cutting away and abstracting piecemeal the part or parts which occasion the obstruction, and then abstracting the general mass of the body.

EMERUS. See CORONILLA.

EMETIC TARTAR. See ANTIMONY.

EMIGRATION. Removal from one country to another, for the purpose of permanent residence. Every man born free, or who had obtained his freedom, formerly had the right of emigrating. But as capital and power were lost to a state by the removal of its inhabitants, it was considered, that emigration ought to be forbidden, and the people only allowed to remove from one place to another within the limits of the state. Experience, however, proved that such prohibitions were fruitless, and the only way to guard against emigrations was by the fullest protection of property; by granting freedom of conscience, and the undisturbed exercise of religion; and by not banishing subjects from their country on account of their religious opinions, as was once done (e. g., in France and Saltzburg); by allowing them, under the protection of judicious laws, with the assurance of freedom in trade and commerce, the undisturbed enjoyment of the fruits of their industry; by not exposing them to the oppression of magistrates; and by delivering them from the fear of unreasonable or arbitrary taxes. When we consider how much resolution is required to abandon for ever the home to which man is bound by the strongest ties of recollection, language, and habit, to seek an uncertain fortune in a land of strangers, there is no reason to believe, that large masses will ever emigrate without the most urgent motives. Wherever emigration is common, it is not an evil itself, but only the consequence and symptom of an evil arising from the dissatisfaction of the people with their condition. If things have come to such a state, that men think they cannot obey the laws of their country without violence to their consciences, they ought to be at liberty to seek in other countries religious and political freedom. Besides, in the abstract, emigration is a right inherent in man. Every person does as much as can be required of him, if he obeys the laws of that country in which he chooses to reside, and only very peculiar circumstances can justify the checking of emigration. The most cruel tyranny was exercised by Louis XIV., when he deprived the Protestants of their religious privileges, and endeavoured to prevent their emigration. The end of government is the welfare of the citizens, and they are at liberty to retire from the state when their welfare is no longer provided for by the state. In America, the right of emigration is as indisputable as the right of eating and drinking. It is one of the fundamental privileges of the English nation, also, to leave the country without special permission, which is limited only in regard to those who stand in some particular relations to the state, such as magistrates or soldiers: and, in certain cases, it may be taken away by the writ *ne exeat regno*, under the great or privy seal. Acts of parliament have often been passed, by the English government, to prevent its citizens from engaging in foreign military service; for instance, in that of the South American insurgents, in 1819; but these were not directed against emigration. The emigration of manufacturers of wool, silk, iron, &c., has been forbidden by separate laws (by those of 1719, 5° Geo. I., cap. 27; 1740, 23° Geo. II., cap. 13, and 1782, 22° Geo. III., cap. 60). The only punishment, however, for emigrants of this class, declining to return on receiving a summons to that effect, is the loss of citizenship. Those who instigate them to quit the country are liable to fine and imprisonment. The French code also, at least since 1789, has permitted unlimited emigration; and the laws since made against emigrants were only owing to the hostile spirit of most of those who emigrated; for the emigrants were unwilling to give up their right of citizenship in France, and attacked the new government in the ranks of its foreign invaders. By the act of the German confederation, article 13, the right of emigration is allowed to all the members of the confederacy. Well founded information in regard to the dangers that threaten emigrants in foreign countries, measures for increasing the means of labour, the removal of the artificial restraints, by which the great mass of wealth is kept in a few hands, freedom of trade,—these are the means by which a spirit of emigration may be checked, and the love of home revived. Prohibitions of emigration are unjust, as well as impolitic, and always prove, that a government which allows them has an incorrect idea of its rights.

The principal countries from which emigration at present takes place to the United States, are Great Britain, Ireland, Switzerland, Alsace, Wurtemberg. From England and Ireland, a large emigration takes place, also, to Canada, New South Wales, Van Diemen's Land, &c.; from Wurtemberg and Prussia to Russia and Poland, which, however, has been less extensive of late; from the Eastern and Northern States of the United States to the Western States; of coloured persons from the United States to Liberia in Africa, and to Hayti,—very few, however, in number, particularly to the latter country.

EMOLLIENT. An external medicinal application which softens the parts to which it is applied, or which diminishes their stiffness, and reduces their rigidity into suppleness.

EMPETRUM. See CROWBERRY.

EMPHYSEMA. A soft tumour or series of soft tumours occasioned by the admission of air into the cellular membrane or cellular tissue of an animal. Butchers often produce an artificial kind of it in veal, by blowing with their mouth into flaccid parts of the carcass, and making the cellular tissue rise into apparent plumpness. Emphysema in the living subject is caused sometimes by the entrance of the atmospheric air into a wound, but far more frequently by the internal morbid action of pestilential epidemics, and by wounds and irretention of the trachea, the bronchia, or the substance of the lungs. It is sometimes confined to a particular part of the body; but, in many instances, it diffuses itself through many parts, or even throughout the whole cellular tissue from head to foot, and renders the animal a bloated, unsightly, inflated mass. It is always more or less irritating; and, when extensively diffused, renders the patient miserable, and may affect his life. When it occurs in the horse, the air should be let out by gentle puncturing, and the constitution strengthened by means of tonics; and if it return and prove obstinate, it must be kept down by moderate pressure, gentle frictions, and, if possible, the closing up of the inlet of the air by the excitement of strong local irritation.

EMULSION. A mixture of water and fixed oil, in which the latter is maintained in a state of diffusion through the former, by means of mucilage, fecula, saccharine matter, the yolk of an egg, or a little alkali. Emulsions are bland, milky, and inodorous, and possess the reputation, in both human and cattle medicine, of acting beneficially and at the same time very gently on the pectoral organs. But they require to be strictly extemporaneous preparations; for, in a short time, the oil rises to the surface like a thick cream; and in 48 hours, they are attacked by the acetous fermentation, and in consequence become rapidly rancid.

ENAMEL. The highly polished and exceedingly hard substance which covers all the healthy portions of animal teeth exterior to the gums. See the articles TOOTH and AGE OF ANIMALS.

ENCELIA. A genus of beautiful, small, evergreen, greenhouse shrubs, of the sunflower division of the composite order. The canescent species, *E. canescens*, called in the Hortus Kewensis *Pallasia halimifolia*, is a native of Peru, and was introduced thence to Britain in the latter part of last century. Its stem is much branched, and about 2 or 3 feet high; its leaves are large, hoary, and ovate triangular; and its flowers are produced in corymbs, and have each a dark purple disk and about twelve fine yellow rays, and usually appear in July. The halimus-leaved species, *E. halimifolia*, called by Willdenow *Pallasia grandiflora*, is similar in height and habit to the preceding, and was introduced about 20 years ago from Mexico.

ENCHANTER'S NIGHTSHADE,—botanically *Circæa*. A small genus of handsome, hardy, perennial-rooted, herbaceous plants, of the order Onagrariæ,—that to which the clarkias, epilobiums, œnotheras, and fuschias belong. The common or Parisian species, *Circæa lutetiana*, grows wild in churchyards, hedge-bottoms, orchards, shady woods, and other shady places in Britain. Its root is powerfully creeping, and mightily prolific of new individuals; its stem is round, branching, and about 20 inches high; its leaves are opposite, heart-shaped, waved, slightly toothed, dark dull green above, and pale below; its flowers are produced at the ends of the stalks in loose compound spikes, and are small, two-petalled, and whitish-red, and bloom from June till August; and its fruit is a rough capsule, or hookedly bristly burr, enclosing two oblong seeds.—The mountain species, *C. montana*, grows wild on the mountains of Britain, but usually has only one-fourth of the height of stem of the common species, and blooms from June till September. The intermediate species, *C. intermedia*, was introduced about 25 years ago from continental Europe.

ENCLOSURE. A piece of ground surrounded by a fence; or, according to an obvious figure of speech, the fence which surrounds the piece of ground. Enclosures in towns are designed to protect yards, plots, and buildings from the intrusions and depredations of man and of the lower animals; and enclosures in the country are designed either to mark and maintain the separation of contiguous estates,—to confine depasturing animals or flocks within given limits,—or to protect cultivated plants, whether trees, grain, esculent herbs, or pasture grasses, from the depredations of men, and the aggressions of wild animals or of stranger cattle. Enclosures throughout estates, in the present improved condition of agriculture, prevent the trespasses of man and beast, shelter corn and cattle against some inclemencies of weather, afford flocks protection and peace while they are feeding or at rest, beautify the face of the country, enhance the value of land, relieve the farmer's mind from care as to the safety of his crops and flocks, and impart confidence to the landlord that, so long as he maintains them, they will secure the conservation and even the improvement of his estate.

The earliest enclosures probably dated as high as the origin of landed property, or the appropriation of particular districts and tracts by families and individuals of nomades and shepherd-patriarchs; but they seem to have been made on only the best descriptions of land, and to have consisted only in the erection of boundaries or marches. When population increased, and agricultural produce rose in value, lands of second-rate quality were also appropriated and enclosed; when population multiplied, and agricultural produce became dear, all lands but the very poorest were divided and enclosed; and when population became dense, and agricultural produce rose to such request as sometimes to realize famine prices, even the hungriest and most churlish soils which possessed any capability whatever of profitable culture became enclosed. Hence the steady and rapid progress of the work of enclosing waste lands, dividing commons, and fencing moors and uplands within Great Britain during the last century; and hence, too, some comparatively modern acts of the British Legislature, first for promoting the division and enclosure of particular estates, and next for facilitating the enclosure of every profitable piece of land within the empire.

An ancient and very prevalent method of enclosing the parts of an estate or a farm was simply to separate the arable lands from the pastures; and this method was, at a comparatively recent period, common in Britain, and still lingers in the outskirts of the Orkneys, the Shetlands, and some other remote and unimproved districts, under the name of infield and outfield. The ancient Egyptians intersected or subdivided the rich corn-lands of the Nile by means of canals and ditches; the ancient Greeks probably had no other enclosures than ring-fences round arable lands; and the ancient Romans enclosed gardens and orchards, made ring-fences round arable lands, and had enclosures for deer, wild boars, and other wild animals, but neither subdivided their corn-lands into fields nor converted their pastures into meadows and sheltered sheep-walks. Wherever modern farming continues so antique and rude as to consist simply of the two unintermingled departments of tillage and grazing, the ancient sparse and slovenly method of enclosure is still more or less practised; but wherever farming has the improved and rational character of alternate husbandry, whether in a merely rudimental or in a fully vigorous condition, a subdivided, multiform, and minutely sheltering and protecting method of enclosure has, in some degree, been found necessary. Throughout France, in consequence of the great subdivision of property occasioned by the extinction of the law of primogeniture, field enclosures are of rare occurrence, and rows of trees, a few march-stones, or even distant series of single trees, frequently serve as the boundaries of estates. Throughout Germany, Switzerland, Spain, and Italy, enclosures occur chiefly in the immediate vicinity of villages and farm-houses, and a large proportion of the tillage lands are quite open and exposed. But throughout Holland, Belgium, and a great part of the south of England, hedges and hedge-row trees are so multitudinous and superabundant as to crowd and almost choke the landscape. Throughout Ireland, too, enclosures, though usually of a bald appearance and often of inefficient character, are so numerous and minute as to cut most of the arable lands into mere plots and patches. In the north of England, however, and in many of the lowland districts of Scotland, the prevailing enclosures possess admirable adaptation to the improved condition of agriculture, and are abundantly creditable to the economizing and utilitarian spirit of the age. "There, not only whole farms are enclosed, but the size of the enclosures conforms to that system of husbandry which is suited to the nature of the soil. There, the growing crops of all kinds receive shelter from the vicissitudes of the weather, and protection from the depredations of live stock; and the live stock themselves enjoy, as a recompense for their confinement within the enclosures, peace and plenty unmolested."

Enclosures, though in their own nature highly and unqualifiedly beneficial, may be, and often are, so constructed as to entail upon a farm considerable disadvantages and losses. Enclosures suitable for one kind of lands, may be decidedly unsuitable for another kind. Enclosures of small and multitudinous character upon low fertile lands, occasion a needless and somewhat great waste of surface, and considerably embarrass the operations of tillage and of horse-hoeing husbandry. Enclosures of thick, bushy, overgrown hedge, especially when unnecessarily numerous, produce too much shade, harbour insects, dilute the fertility of the margins of fields, and occasion sheep and cattle fully as much torture as shelter. Enclosures of inconvenient shape, and disposed unconformably with the slope or position of the ground, cause excessive waste and embarrassment, and ought, in most instances, to be totally destroyed and remodelled. Enclosures formed of plants with decurrent roots, or enclosures of perfectly suitable plants intermixed with such trees as willows, poplars, the common elm, or the common ash, damage drains, deteriorate or destroy the borders of the fields, and make large underground encroachments upon the space which ought to be occupied by tillage crops. "It has also been remarked," says Sir John Sinclair, "that enclosures are attended with this disadvantage, that they retain moisture among the trees and hedges, and prevent the full effect of wind in drying the crop during harvest. But this inconvenience is in some degree compensated by the corn becoming earlier ripe, from the warmth which the enclosures furnish. Some have imagined that the soil might be injured by the greater evaporation which the warmth of enclosures may occasion; but it can hardly be disputed, that evaporation is more promoted by free air and wind than by heat." Yet though these latter evils are fanciful, those from ill-adaptation, over-abundance, bad shape, wrong material, and intermixed decurrent-rooted trees are real, and ought to be studiously avoided. Mr. Grant, speaking in 1845 of Devonshire and the neighbouring counties, and alluding to the enclosure-statistics of 10 parishes as a specimen of the whole district, says, "The hedges occupy in some cases fully 10 per cent.,—but, on an average of these ten parishes, 7½ per cent. or 1 acre in 14. They shade and injure at least half as much; most persons, landlords as well as tenants, whose opinions I have asked, say quite as much more. They harbour birds and vermin which injure the crops; and that this is no small evil any one may satisfy himself, by going into a field just before harvest. They are nurseries for weeds; they prevent that free circulation of air, so necessary to the healthy growth of plants as well as animals; they are obstacles to the drainage of the soil, the roots found in them frequently choking up the drains. They are expensive to erect as well as to keep in repair. The soil on each side of them is generally thinner, from the materials for making the banks being taken from it. So many small enclosures require a much greater number of gates; which have to be kept up and renewed; and they cause a much greater number of small lanes and cart-tracks leading from one place to another. The fences being in the most cases crooked, and the fields of every shape but right angled, the labour of every operation of the farm, particularly ploughing, is most materially increased. This evil is anything but a trifling one, especially when to it is added the labour caused by the roots of trees which shoot out into the fields. In any parish this is felt; but in such a parish as Rewe, where there is much timber, one may see, when the ground is laid open by the plough, that the roots of the trees cross each other from opposite sides of the field."

Carse lands, or other flat clay lands, in consequence of their unsuitableness for permanent pasture, require enclosures less as a protection from the trespasses of cattle than as a shelter from the weather; yet, though in many instances thought too valuable to be subdivided otherwise than by drain-trenches, they obviously acquire an increment of value from judiciously disposed thorn-fences. Enclosures on all parts of all farms of mixed husbandry are indispensable. A division fence ought to be run between the clay portion and the loam portion of every estate which consists partly of clay and partly of loam. Enclosures for the sheltering of flocks on mountain-pastures, frequently require to be aided by belts and masses of plantation, and, in all cases, ought to be disposed in large divisions. The enclosures of extensive upland sheep-farms, besides being so comprehensive as to allow amplitude of scope proportionate to the scantiness of the herbage, ought to comprise a ram-park for the seclusion and sole use of rams, an hospital-park for the extra-shelter and rich feeding of diseased sheep, a water-meadow or park of early grasses, and plots or fields of sufficient extent for the raising of supplies of turnips and other green food for the pinching periods of winter and early spring.

The position of enclosures ought to be determined chiefly by the inclination of the ground and the direction of its ridges. The corners of all enclosures of arable land ought to be right-angled, because the plough can turn over a greater aggregate of surface in four square corners, than in two obtuse-angled and two acute-angled corners. In most circumstances, particularly on stiff lands, a perfectly square enclosure is the shape most economical for tillage; but when the ploughing is always in one direction, the parallelogram or oblong rectangle is decidedly preferable; and, in the latter case, the longer sides of the parallelogram ought if possible to extend east and west. Contiguous or successive enclosures ought all to run parallel to one another; and whenever any wedge-shaped or non-rectangular piece is unavoidable, it ought to be disposed on the border of the farm. A fence along the summit of a broad-backed rising-ground affords more shelter than in any other situation, and eminently confers it on both sides; so that, whenever other circumstances permit, the lines of enclosure should be selected along the highest ground. "But it generally happens that the lower ends of fields cannot be enclosed in a straight line,—a rivulet or hollow between two rising grounds frequently terminating their lower ends. In that case, the fence ought to follow the course of the water or hollow ground, in order to provide an egress for the surface-water coming from both sides of the rising ground. A serpentine fence in a hollow, contrary to one on a rising ground, affords more shelter than a straight one, in the direction of the wind, which almost always takes the direction of the valley. A public road or canal passing through a property, or an old plantation growing in the middle of the land, affects the shaping out of enclosures. Whether any of them exists before or after the land is enclosed, the irregular sides of the enclosures which alone should contain wedge-shaped ridges, should be placed next the obstacle."

On carse farms, and on farms of every other kind devoted wholly to the produce of a maximum quantity of corn, the number of enclosures ought to correspond with the courses in the rotation of crops. A clay farm of 210 acres, with a rotation of fallow, wheat, barley, grass, oats, or wheat, beans, and wheat, or any other rotation of seven courses, might be divided into either 14 fields of 15 acres each or 7 fields of 30 acres each; but 14 fields would occasion an unnecessary waste of ground with the occupancy of fences, and an unnecessary outlay for the fences themselves, for gates, and for keeping the enclosures in repair; and each of 7 fields of 30 acres, if disposed in a parallelogram of 580 yards in length and 250 yards in breadth, is not too large for enjoying all the sheltering benefits of the fences, and, if level, would freely allow the draught horses of the plough to traverse from side to side at a single breathing-time. On farms of mixed husbandry, whatever be the rotation practised, the welfare of live-stock is as much an object of solicitude as the economizing of ground and labour, and is very materially promoted by smallness of herds and freshness of pasture; so that, on farms of this kind, an enclosure of about 25 acres, disposed in a parallelogram of about 450 yards by 270, would be a very suitable size and shape, adapting itself at once to facile labour in the tillage years of the rotation, to the feeding of sheep on turnips on the ground in winter, and to the grazing of cattle in the summer and autumn of the years of lea-land. An excellent size and disposition of farm with loamy soil and under mixed husbandry—excellent for both the tenant and the landlord—is 500 acres so divided as to assign four fields of each 25 acres to each of the systems of rotation. But two or three small enclosures, of from one acre to five acres each, and situated in the vicinity of the farm-offices, are requisite on every large or moderately sized farm which rears live-stock; and these may be used for rams when out of season, for calves when weaning, for ewes when lambing, for a mare and her young foal till she acquire strength, for a stallion at grass, and for the seclusion or the special shelter and careful feeding of sick and convalescent animals. A farm of loamy soil, under the mixed husbandry, and not more than 125 acres in extent, ought, for the sake of economy in ground and management, to have only as many fields as there are years in the rotation,—five fields of 25 acres each, if for a five years' course, or six fields of nearly 21 acres each if for a six years' course; and when a smaller quantity than an entire field is at any time wanted for a purpose which requires enclosure, it may be separated by some cheap and facile temporary fence. The principal kinds of enclosures, and the methods of making and preserving them will be discussed in the articles FENCE, HEDGE, and WALL.—*Miller's Dictionary by Rennie.—Quarterly Journal of Agriculture.—Journal of the Royal Agricultural Society of England.—Sir John Sinclair's Code of Agriculture.—The Farmer's Magazine.—Doyle's Practical Husbandry.—Loudon's Gardener's Magazine.*

ENDEMIC DISEASES. Diseases which prevail in particular districts, but do not extend into other districts. They are not frequent among brutes; yet a malignant disease which prevails among horned cattle in some parts of continental Europe, and is quite unknown in Britain, may be referred to as a formidable instance.

ENDIVE. Two species of cultivated, herbaceous plants, of the Succory genus. The wild succory, *Cichorium intybus*, is perennial, branching, and about two feet high; the leaves oblong lanceolate and runcinate, a little hairy on the nervures; the flowers axillary, geminate and nearly sessile, of a blue colour, and resembling in size and form those of the dandelion: it likewise belongs to the same natural family, Compositæ. The wild succory contains a milky juice, and has been frequently employed by physicians as a tonic and aperient: when blanched, its bitterness is very much diminished, and in this state it is eaten in soups as a salad, particularly in France, as it was formerly by the ancient Romans: it is also extensively cultivated in Italy for fodder, and the root, when roasted, has been used as a substitute for coffee. Indigenous plants of it occur in some gravelly lands of both Scotland and England. The endive, *C. endivia*, is perhaps only a cultivated variety of the former plant, yet is usually regarded as quite a distinct species, and believed to have been brought to Britain about three centuries ago from India. It differs from the wild succory in being annual, more elevated, and having smooth, entire, or dentated leaves, rarely lobed, and in its flowers being some of them sessile, and others upon long peduncles: it is considered in France one of the best esculents, and is eaten in salads, ragouts, as a pickle, &c.

ENDOCARP. The lowest of the three layers of a pericarp, or the shell or rind which immediately envelopes the kernel of a stone fruit. See the article Pericarp.

ENDOGENS. Plants which form the increments of the growth of their stems by additions to their centre. All are monocotyledons; and the whole group and monocotyledons are often regarded as mutually identical,—endogens being the designation of the mode of growth, and monocotyledons the designation of the structure or unity of the seed-lobe; but a portion, or those which form the increments of the growth of their stems wholly by additions to the top, are sometimes designated acrogens. See the articles Botany and Cotyledon.

ENDOSMOSE. The impulse by which a thinnish fluid percolates animal or vegetable membrane into a thickish fluid from which the membrane separates it. The term endosmose signifies "a rush inward," and was coined and introduced by Dutrochet; but both the word itself and the theory which it designates are rejected by some physiologists, and contested or held doubtful by many. See the article Absorption.

ENEMA. See Glyster.

ENGRAFTING. See Grafting and Budding.

ENKIANTHUS. A small genus of very splendid, Chinese, evergreen shrubs, of the heath family. The five-flowered species, *E. quinqueflora*, was introduced to Britain in 1812, and the netted species, *E. reticulata*, in 1822; and both attain a height of about 4 feet, and bloom in the latter part of winter and early part of spring. *E. quinqueflora* is a symmetrical, tall-shaped, and elegantly outlined plant, with rather sparse foliage; and its flowers are drooping and most handsome clusters of delicate, pendulous, pinkish-coloured bells. Both species require greenhouse culture.

ENNEANDRIA. See Botany.

ENTADA. A genus of tender, climbing, ornamental plants, of the mimosa division of the leguminous order, erected by De Candolle and Adanson out of five or six species of the genus mimosa. The single-spiked species, *E. monostachya*, was formerly called *Mimosa entada*, and is known under the name of entada among the natives of Malabar. All the species are tropical, and attain a minimum height of about 18 or 20 feet.

ENTAIL. An entail includes every species of settlement, from a simple destination, which merely cuts off the heir at law, to a deed which secures the succession to a long series of heirs, and contains the strictest prohibitions from selling, alienating, contracting debts, &c., and guarded by irritant and resolutive clauses. The following admirable account of the law of entail as existing in Scotland, and its most mischievous effects in that country, is from the pen of that acute and unprejudiced observer, 'The Times Commissioner,' in one of his despatches from the Scottish Highlands in October 1846.—We gladly give it a permanent place in the columns of our Cyclopedia:

"Laing, in his 'History of Scotland' (Vol. iv. B. ix.), attributes the passing of the law which gave efficacy to perpetual entails—namely, the 1st James VII., of Scotland, cap. 22, 'An Act concerning Tailzies,' enacted in 1685—to 'the secret alarm of the nobility at the retrospective treasons which they were employed to create.' He says: 'To preserve their estates from forfeiture and their families from ruin, it would appear that they sought an indirect expedient to elude the iniquitous laws and corrupt practices which they were too dependent to reject or resist. Entails had already been introduced in a few instances; but were reprobated, as repugnant to the genius of the laws.' These reasons have, however, long since ceased to operate, and the device which rendered a man only tenant for life of his estate—that in case of forfeiture it might be preserved to his family—has now no defence, when in other respects it operates most injuriously on the welfare of the community. The law thus originated was continued by the nobility and great landed proprietors, 'in order,' says Dalrymple, 'to preserve their estates from commerce, and from falling into the hands of creditors, to whom the prodigality or misfortunes of some of their body might bind them;' about as dishonest and unprincipled as well as impolitic a reason as was ever unblushingly avowed in support of any law whatever.

"I shall now briefly draw attention, in order to a clear understanding of the matter, to what the law is. In England, as you know, the statute *De Donis*, which fixed upon us the same perpetual entails as now exist in Scotland, was, as early as the time of Henry VII., eluded by the invention of common recoveries, a fictitious proceeding in the courts favoured by the judges, or, as Blackstone terms it, 'a *pia fraus*,' by means of which entails were effectually barred, and their mischievous effects avoided; and now, by one of the recent real property statutes, passed in the reign of William IV., abolishing fines and common recoveries, a less cumbrous and more facile mode of accomplishing the same end by deed has been substituted. In Scotland, however, no such happy contrivance has defeated their full and perpetually binding effect.

"A strict entail in Scotland is, in fact, an unbarrable and perfect perpetuity, giving only a life-rent or interest to the present possessor, and marking out his successors down to the remotest remaindermen or substitutes, all of whom have, therefore, an interest in taking care that the present possessor does nothing to bind the estate or burden it in any manner which may affect their contingent interests, and in watching to make every such act null and void. Till a late period, no leases for any long term certain could be given of the lands, as that would be a 'disponing' within the statute. The estate till a recent period could not be charged for improvements, or for the support of younger children, as that would be a 'contraction of debts' within the statute, and the present possessor, if able, was generally unwilling to afford such improvements, at the expense of his younger children, for the benefit of the eldest son, to whom the estate might descend, or probably at the cost of his daughters, for the benefit of some distant male branch of the family appointed to succeed him in default of male issue. The extent to which the tenant-in-tail in possession is watched and fettered by those having vested interests by the deed of entail may be judged of by the following reported case, quoted in Irvine's 'Treatise on the Law of Entail.' It was decided in the case of Dundas against Murray and others, Nov. 29, 1794, that a person who was not entitled to the succession till after the failure of twenty-five intervening substitutes and their heirs, had a competent right of action to prevent the heir in possession from doing any deed by which his contingent right of succession might be affected.

"In order, however, to remedy in some degree the evils and hardships consequent upon the strictness of the law, and to enable proprietors to improve their estates and provide for widows and younger children, two acts of parliament, of a modern date, called the Montgomery and Aberdeen acts, have been passed. The first of these (the 10th George III., cap. 51) enables the tenant-in-tail in possession to grant leases for two lives and the life of the survivor, or for any number of years not exceeding 31 years, and to grant building leases for 99 years; and heirs of entail may become creditors to succeeding heirs for three-fourths of sums laid out in specified improvements, not exceeding four years' rent of the estate, with certain deductions, and to the extent of two years' rent for building or repairing the mansion-house or offices on the estate. The act then enables heirs of entail to avoid all suits for the cost of such improvements, on making payment of one-third part of the annual rents of the entailed estate until the debt is discharged; so that, in respect of this act, the heir of entail may inherit his estate burdened to only one-third of the whole amount of its annual rental. The second act (the 5th George IV., c. 87) enables heirs of entail to grant provisions to wives to the extent of one-third part of the free yearly rent of the estate, after deducting public burdens and interest of provisions to children; and three years' free rent may be charged on the estate for three or more children. By this act, also, the heir of entail may avoid any suit for these burdens upon assigning to a trustee named by the Court of Session one-third of the clear rent of the estate till such provisions are paid off. It is thus almost impossible that both these acts should be called into action at once without ruining the head of the family; for he must keep up the station of his nominal position out of one-third of the rental of the estate, from which, too, have to be deducted all public burdens, as income-tax, poor-rates, &c., still further reducing that third of the rental to about half its amount, or giving, say, £500 a-year to the nominal proprietor of £3,000 a-year wherewith to keep up the family state,—a condition as painful as it is powerless and humiliating.

"A calculaton has, however, been made by Mr. Irvine, in his essay on this subject, which very plainly exhibits the operation of these acts on the previous law. He says: 'Since the next heir is only bound by the first act to give up one-third of his rents, and yet as the debt of which he must at least pay the interest may amount to six years' rent, the principal can scarcely ever be redeemed at all; and, in point of fact, very rarely is. Suppose an estate to be worth £1,800 a-year, six years rent of this is £10,400, of which the interest is £520, which is within £80 of the third part of the total rent; or, in other words, the debt of £10,400 must subsist against the estate till it be discharged, if the next heir pleases, by payments of £80 a-year. Then, under the other statute, the provisions to widows and younger children can only be discharged on a similar principle, and therefore these provisions too have a tendency to become mere annual claims on the estate. The claim of the widow, indeed, ceases with her life, but those of the children endure till the principal sum be paid. 'If, from a conviction of the impracticability of availing himself of both statutes at once, a wise man begins to think which he will prefer, neither side of the alternative can seem very inviting; for the most obvious view of the case is, that he must either improve his estate by leaving his family destitute or provide for his family by leaving the estate unimproved.' This is certainly no very flattering picture of the state of the law in 1826; since which period the income-tax and poor-rate assessment have been imposed on proprietors as public burdens; and the Drainage act of last session, if acted on by operating as a prior rent-charge for the interest of the amount borrowed, will still further reduce the entailed proprietor's income.

"But perhaps it may be thought that entails are few in number, and may embrace but a small territory; and that therefore, though mischievous, the law is of no national importance. The following summary from Mr. Irvine's book, will, however, show the number of entails and the extent of soil brought under the operation of these laws. The calculation is extracted from the official register: 'The gradual progress of entails may be exhibited by dividing the time which has elapsed since 1685 into periods of 20 years, and stating the number of deeds which have been recorded during these respective periods:—

"From 1685 to 1705	79 entails
— 1705 — 1725	125 —
— 1725 — 1745	158 —
— 1745 — 1765	138 —
— 1765 — 1785	272 —
— 1785 — 1805	360 —
— 1805 — 1825	459 —
	1,591'

"Supposing the number of entails during the 20 years elapsed since 1825 to bear an equal proportion to this rate of increase, and there is no reason to draw a contrary conclusion, we shall have now existing in Scotland about 2,000 deeds of entail. According to a statement made by Sir G. Sinclair, published in 1814, in the 'General Report of the Agricultural State and Political Circumstances of Scotland,' it appears that the valued rent of Scotland was £3,804,221 Scots. The valued rent of estates held under entail was stated to be £1,213,159 17s. 9d. Scots. The unentailed valued rent, therefore, amounted to £2,591,061 2s. 3d. Scots. Acording to this statement, nearly one-third of the property of Scotland, estimated by its valued rent, was at that period possessed under entails. Mr. Irvine, however, who wrote his book in 1826, has brought this estimate more near to his own time. He says: 'By computing at a moderate rate the value of properties entailed since 1811, and by taking into view the extent of property conveyed to trustees to be entailed as soon as debts are paid off, and the amount of funds conveyed to trustees for the purpose of purchasing and entailing lands (with which the experience of every man must furnish him with many instances), the conclusion may be drawn that about one-half of the territorial property of the kingdom is now or will soon be under the fetters of entail, and the proprietors subjected to all the inconveniences attending their restricted rights of property, and the hazard and expenses attending judicial discussion for the purpose of rendering effectual or of defeating the settlements of their predecessors.' Allowing, then, for the lands which may have been subjected to the law of entail during the last 20 years, if the progress of entailing property has at all gone on in the same ratio as in preceding years, it is within the mark to say that at least one-half of the whole of Scotland is now tied up and subjected to the freezing and starving influence of this restrictive law.

"It now remains for me to show to you what have been the effects produced by the law on the heirs of entail themselves, and on the country generally. On this subject I shall again quote Mr. Irvine's book. At page 79 he says, speaking of the effect of the law on the heirs of entail,—'The entailed proprietor labours under grievous hardships. Upon his succession he is probably burdened with provisions to brothers and sisters, which, however inadequate for their suitable education and support, he may not have the means to pay without the aid of friends. The prosecution of his own plans of life is obstructed by his limited credit. It is expected that he will live suitably to the rental of the estate, of which he is nominally the proprietor, but really only the life-renter. If prudent, he is surrounded by difficulties in providing for a family and improving his estate; and, if extravagant, his creditors may be under the necessity of attaching his rents. He cannot borrow in the ordinary way of loan to supply his wants. His early expectations of succession and station in society naturally lead to a mode of living and habits by which such debts are contracted as his limited credit can command, arising rather from the situation in which he is placed than from general extravagance. He cannot command money to improve his property, however much it may be susceptible of it, unless by encroaching upon his means of granting provisions to a family. In granting leases he is limited in the encouragement he can give to improving tenants at the commencement of the lease, and, if fully aware of his restricted situation, he cannot honestly bind himself to pay for ameliorations at the conclusion of it. The law seems fixed by various decisions that a subsequent heir of entail in possession, although deriving the benefit of stipulated improvements, is not bound by any such obligations contained in leases granted by his predecessor. The tenant must seek his relief against the representatives of the person with whom he contracted.'

"The 'Edinburgh Review,' in a review on this book, says with much force: 'A Scotch proprietor under a proper entail cannot name his own heir. The heir in expectancy may be his son, who may be rebellious merely because he knows that his father cannot deprive him of an inch of his inheritance; or the holder of the property may have a family of daughters, who he may be certain will be expelled, the instant that he is dead, in penury from the place where their lives have till then been passed, in order to let in a stranger, who may be called to the succession because it pleased the ancient founder of the entail to have a preference for persons of the masculine gender. He cannot part, for a price or without it, with a single clod. He cannot employ any part of the estate as a source of credit, except by complying with the vexatious and unsettled provisions of an inextricable statute; he cannot venture to advance money even for the permanent improvement of the estate with any hope of ever being repaid; and, if his predecessor has been fortunate enough to act in conformity with this statute, the next heir only finds himself so much the poorer. It is only by availing himself of the permission of a still later act of Parliament that he can make any provision for any member of his family. But if one or two preceding heirs have got in before him, he is doomed to know this statute chiefly by being its victim. He must keep up the mansion-house, and can neither let it nor the ground in connexion with it beyond his own life, although it may have pleased a predecessor otherwise rich to make it so splendid that it would ruin him to live in it. Every other landlord can encourage a tenant to lay out money in improving a farm by entitling him to be recompensed by the person in possession at the end of the lease; but it is denied that this can be done by a proprietor under an entail. The consequence of which is, that he must either grant an ordinary lease, which leaves the estate unimproved, or must advance the money himself in the first instance, which he is generally incapable of doing, and the whole of which his family will lose if he should happen to die the next day.' The same publication, in noticing the evil effects of the law, says further with more of plain truth than of flattery,—'This law enables every fool to fetter that part of the public property in which the public has the greatest interest, as long, and in whatever manner his folly may dictate; and, lest our admiration of antiquity should decline, it puts it out of the power of any wise successor he may have to withdraw from a station which he can no longer sustain, and insists on fastening them all successively on society as the representatives of ancient races — though they be reduced to a state of pecuniary difficulty which renders them the humiliation, and not the pride of the old family, and makes the recollection and the signs of what they once were the most cruel circumstance in their condition.'

"A large proprietor in the Western Highlands, whose estate is in this manner tied up, thus writes to me on this subject, as to his experience and knowledge of the evil effects of the law: 'In making inquiry into the state of the western part of Scotland, you find generally large properties, under strict entail, producing a smaller rental than they yielded 30 years since; large tracts of waste land, yet capable of improvement at a moderate outlay; a considerable population almost wholly unemployed, or obliged to go to the south for work; and landlords, though nominally rich, in reality extremely poor, utterly unable to employ the people on their estates or to improve the land they possess. To produce a better state of things, it has been proposed at one time to promote emigration to Canada, and raise the value of land by converting the poor people's holdings into sheep farms. At another, to encourage fisheries and make the sea pay for the land. But why send people at great expense to Canada when there is a Canada of large extent at home? Why look to precarious fishings, when by calling into activity the unemployed labour of the country you may make the land keep its population in comfort and industry, and at the same time raise its value?' These are most pithy inquiries; but under the blighting influence of the law of entails 'the unemployed labour of the country,' like its vast uncultivated tracts, must run to waste.

"I shall finish with Adam Smith's opinion of the impolicy of this law. He says: 'When great landed estates were a sort of principalities entails might not be unreasonable. Like what are called the fundamental laws of some monarchies, they might frequently hinder the security of thousands from being endangered by the caprice or extravagance of one man. But in the present state of Europe, when small as well as great estates derive their security from the laws of their country, nothing can be more completely absurd. They are founded on the most absurd of all suppositions—the supposition that every successive generation of men has not an equal right to the earth and to all that it possesses; but that the property of the present generation should be restrained and regulated according to the fancy of those who died perhaps 500 years ago.' Though necessarily, from its brevity, this is a very inadequate view of so extensive a question, yet it is enough to point out to us that a law which we quietly permit to remain on the statute-book has quite as much, if not more, to do with the misery which exists in the Highlands of Scotland as the criminal neglect of their duties of all the proprietors put together, whatever that may amount to, and which I by no means wish to shield. Over more than half of Scotland this law compels a vile example to be set, which keeps in countenance the negligent proprietor; it gives an artificial value to land from its scarcity, locking it up from commerce. It therefore raises the rental of land in order to afford a fair interest for the high price paid for its purchase. It prevents men of capital, who would have the means of improving, from purchasing the estates of poor and embarrassed men who cannot improve or give employment to the people; and all for what? To enable some few 'Lairds o' Cockpen' to fancy themselves as 'great' as they are 'proud' of their penniless 'lang pedigree.' But the days are gone by when the existing merit of the age can be crushed and kept back by the perpetuated merit of past ages vauntingly worn by unworthy successors. The possessor of an ancient title and estate, won by the valour or the wisdom of his ancestor, has surely vantage ground enough in the race of life without a law to perpetuate both to him; if he possesses prudence and wisdom and virtue, he will easily retain both, and wear both honoured and respected; if he possesses neither prudence nor wisdom nor virtue, the sooner he loses his elevated position the better will it be for the interests of the country; and any law which attempts to maintain and uphold such an one in his undeservedly high station must be mischievous in its operation."

ENTANGLEMENT OF THE BOWELS. A twisted and knotted state of the intestines of an animal, occasioned by very severe colic. It is accompanied with extreme and continuous torture, and may be suspected to exist in a prolonged and perfectly stubborn case of violent colic; but it is incapable of cure or of any special treatment.

ENTERITIS. Inflammation of either the peritoneal or the muscular coats of the intestines of an animal. It is not uncommon in horses and cows; it is often called red colic by farriers; and it has some causes and symptoms in common with those of spasmodic colic. As the medical treatment of it requires to be prompt, and is very different from that proper to spasmodic colic, the diagnosis of it demands great perspicacity and considerable skill. See the articles Colic and Diagnosis. Its progress is rapid, and its danger imminent. The most common causes of it are plunging in a heated state into a pond or river, dashing cold water upon the heated animal, drinking cold water when the system is heated, prolonged and severe costiveness, neglect or improper treatment of spasmodic colic, and the translation of inflammatory action from some other part of the body. A horse affected with it is restless, has a hot skin, wants appetite, is costive, has a parched mouth, kicks at his belly, stamps on the ground, scrapes and paws upon his litter, looks often and painfully round to his sides, and has a small and rather wiry pulse at about 90 or 100. When his stamping remits, his pulse softens, and his costiveness gives way, he may be expected to recover; when his extremities continue cold, his pulse accelerates or wavers, and his costiveness either is obstinate or finds relief only in a black and fetid discharge, he is in a very critical condition; and when he has cold sweats, delirium, and excessive debility, and his belly becomes increasingly tense, he will almost certainly sink under the disease. Enteritis is frequently fatal within 24 hours of its commencement; and even in the most favourable case, it cannot be successfully combated by medicine, unless it be vigorously dealt with before the second day. The grand remedies are bleeding, relaxing the bowels, and blistering; and all the three are usually needed. Blood, in a young, large, and plethoric horse, may be taken to the amount of 6 or 7 quarts; and ought to be drawn rapidly and from a large orifice. The relaxing of the bowels should be effected chiefly by means of back-raking or other mechanical appliance; and partly by means of laxative glysters, or—in the event of the glysters proving ineffective—by means of mild laxative drinks. The blistering or artificial excitement of external inflammation requires to be both great and speedy, and cannot be induced with sufficient rapidity and power by any ordinary application of cantharides. One method of effecting it is to foment the belly for 15 or 20 minutes with hot water, and then apply a poultice of mustard and oil of turpentine; another, is to rub profusely in tincture of cantharides or a turpentine decoction of cantharides; and another, when no better one of an active nature can be readily had, is to scald with boiling water poured direct from the kettle or to scorch with a hot shovel drawn athwart the belly.—The causes, symptoms, and treatment of enteritis in the cow, are nearly the same as in the horse.

ENTRY OF FARMS. The time of the year at which out-going tenants of farms leave them, and in-coming tenants enter. This, and the usages which accompany it, are exceedingly various, not only in the different counties of Britain, but frequently in contiguous districts of a single county. When the customs of entry observed in the different counties are grouped into one statement, or exhibited in a continuous view, as in Kennedy and Grainger's Treatise on the Tenancy of Land, they appear to be a confused mass of the most conflicting materials, and are vastly more fitted to bewilder and confound an inquirer than to enlighten and direct him. In some instances, the first day of January is preferred as the time of entrance, on account of its being the commencing day of the civil year; in others, the second day of February, or Candlemas day, is preferred, on account of its having been the term in use among the ancients; in others, the 25th of March, or Lady-day is preferred as, on calculation, the most suitable time for taking possession jointly of houses and land; in others, May-day or Whitsunday, is preferred on account of its being the general term of all classes of the population for removing to houses; in others, Michaelmas, or the 29th day of September, is preferred on account of its affording the in-coming tenant full scope to make winter preparation throughout the farm; and in others, Martinmas or the 22d of November is preferred, on account of its occurring at or near the slackest or least connected point of the continual series of farm operations. In very many instances, also, some two of these terms of entry are conjointly in use—the one as the term of entry to the farm-houses, and the other as the term of entry to the land. Yet diversified as are these times of entry, the usages which prevail in the valuations, transferences, and conditions which accompany entry, are still more diversified. See the articles LEASE and TENANT.

The principal object dependent on the time of entry is to make the least possible derangement in the cultivation of the farm; and the main difficulties to be disposed of are the use of the last or of the growing crops, and the use and preparation of the land which is in the course of tillage. Now the processes of cultivation constitute so continuous a series, and are in so many ways linked into one another, that, more or less at any point or on any day of the year which could possibly be fixed for change of occupancy, large portions of crops would be found either growing or unconsumed, and large values of labour, manuring, or other accessories of cultivation would lie invested in the ground, and require remuneration to the out-going tenant from the in-comer. Each of the terms at present in use, is encumbered with its peculiar difficulties, and might be made more advantageous than it is by improvements in the accompanying customs of removal. But, for the sake of preventing litigations, of accommodating parties who remove from a district under one set of existing usages to a district under another set, and of promoting the general harmony and the aggregate well-being of the agricultural community, some one term, with accompanying code of usages, ought, to the exclusion of all others, to be appointed for universal observance; and this, all things considered, might, with the utmost probable maximum of advantages, be Lady-day. Bayldon, in his work on Rents and Tillages, makes this proposal, and accompanies it with the following statement:—"The fallow for wheat must be prepared by the quitting tenant, and the in-comer is liable for rent and taxes, seed, labour, and manure, if it be paid for by custom; if not, for carting only. If the crops be taken at valuation, rent and taxes will be deducted from the amount. In order that the winter ploughing may be performed at the proper time, accommodation may be provided by agreement at Candlemas, or at 1st of January, for a part of the necessary strength, and the out-going tenant may be bound also by agreement to plough the lands to nearly the term of quitting, on being paid the customary charge, such a part of performance not to include all the work necessary to be done, so as to interfere too much with his avocations elsewhere. Such an arrangement would carry on the work at the proper season as if no change was intended: the wheat crop being transferred to the in-comer, and the spring crops being sown by him, the out-goer has no further to look after, and the in-comer enters at once into the sole possession. He gets the crops of that year, and consequently pays rent at the expiring of the first six months after entry, and pays none after he quits. If custom would yield and advance a step, and allow no valuation where a crop of any kind has been got, the arrangement would be much simplified; but if valuations must endure, the tillages of fallows and green crops would be valued as usual, and for the labour performed. The crops, if not taken, will be used by the out-goer as usual, and the straw left free. At Lady-day, straw and hay and green crops will be mostly consumed, and the dung will be in the yards, or carted out and preparing for use. If any hay be left, it may be valued; but dung and straw should in all cases be free. Pasturing will be prohibited, except by the usual number of sheep; and payment of seed and labour, for young grasses is in all cases understood."—*Kennedy and Grainger's Present State of the Tenancy of Land in Great Britain.—Bayldon's Art of Valuing Rents and Tillages.*

EPACRIS. A genus of beautiful, Australian, evergreen, small shrubs, forming the type of the natural order Epacrideæ. This order is so nearly related to the heath family as to have been regarded by some botanists as a division of it; but it is treated as perfectly distinct by De Candolle, Endlicher, the majority of other distinguished botanists, and probably all market cultivators. The anthers of all its plants are one-celled and destitute of awns or tails; while those of all the heath order are two-celled and more or less awned. With the exception of one species from within the arctic circle, and a very few species from the Sandwich Islands and New Zealand, all the known species of epacrideæ are natives of New Holland; and without any exception, they are elegant shrubs, with dry and prickly-looking leaves, and with handsome tubular flowers, principally white and red. About 80 species have been introduced to the greenhouses of British gardens; and these are distributed into two groups of respectively eight and ten genera,—the former represented by the genus epacris, and the latter by the genus styphelia.

The genus epacris, though quite unknown in Britain till about 43 years ago, now occupies a large space in our greenhouses, and shares largely the attention of our public nurserymen. Upwards of 20 species of it are in cultivation,—all Australian, and from 2 to 4 feet high; and five of these were introduced in 1803 and 1804; and all the others, with one exception, have been introduced since 1821. The great-flowered species, *E. grandiflora*, is one of the longest known and most extensively diffused. Its stem is usually about a yard high; its leaves are small, rigid, and sessile; and its flowers are produced throughout most of its length, are long narrow tubes of rosy crimson and pleasant white, and usually bloom from January till June.—The pitted species, *E. impressa*, was introduced in 1824. Its stem is smooth, pubescent, branched, and usually about 2 feet high; its branches are covered with a soft white pubescence; its leaves are sessile, mucronate, and narrowly lanceolate; and its flowers are axillary, arranged in twos, smooth, about

8 or 10 lines long, and of a bright rose colour, and appear from April till July.—The autumnal species, *E. autumnalis*, called also *E. refulgens* and *E. Cunninghami*, seems to be a hybrid between the great-flowered and the pitted. Its stem is erect and strong; its leaves are small and oval; and its flowers are crimson-coloured, and bloom during late winter and early spring.—An epacris may be slowly but certainly propagated from cuttings at any time of the year; yet it does best from hard, stubby, bottom cuttings in autumn.

EPHEDRA. A small genus of curious woody plants, of the coniferous order. The two-spiked species, *E. distachya*, is a sub-evergreen shrub of rocky mountains near the coast of France, Spain, and Italy, and has been cultivated in the shrubberies of Britain since the latter part of the 16th century. It has a height of only about 2 or 3 feet on poor soil, but attains a height of 5 or 6 feet, with a tree-like outline, enlarged leaves, and greatly improved appearance, on flat moist soil. Its stem when old has a rough, dark-coloured, dirty-looking bark; its branches are few, and have a fine green bark while young, and a yellowish, reddish, or brown bark when old; its joints of both stem and branches are numerous,—and many of them are protuberant and send out such a profusion of shoots and leaf-like spray as to give the plant a close bushy appearance; and the leaves or leafy spray grow opposite in pairs, are alternately produced at every joint in opposite directions, and, in good soil, branch out in a curious, horse-tail-like manner to a great length. The singular leafing habit of the plant has occasioned it to be frequently called the shrubby horse-tail. The leaves and shoots emit so rich a fragrance in spring as to cause the plant to be much esteemed for its sake; and yet when they are bruised in winter, they give out a very disagreeable, fetid odour. This plant propagates itself, and may with great facility be artificially propagated by layering.—The one-spiked species, *E. monostachya*, is a native of Siberia, and has similar habits to the preceding. The loftiest species, *E. altissima*, was introduced about 20 years ago from Barbary, and is a twiner of between 20 and 30 feet in height.

EPHEMERA. The name of a genus of insects, belonging to the order *Neuroptera*, which is thus characterized: wings four, erect, reticulated, posterior ones much smaller; extremity of the abdomen furnished with three filiform appendages. *May-fly* or *day-fly* is the popular name of the ephemeræ, of which there are several species. From the short duration of the existence of these insects, the term *ephemeral* has been derived, which is used to signify any thing short-lived or temporary. The larvæ, or grubs, inhabit standing and running waters, usually abounding in the latter. As baits for fish, they are much esteemed, and the perfect insect is also used for the same purpose. Great numbers fall into the water, and become the prey of fishes and birds; and they exist in such quantities in Carniola, that when dead they are collected in baskets, and even in carts, to be used as manure for the land. We are informed that the country people think they have been unsuccessful, if each does not procure 20 cart-loads of them for that purpose. Those who have witnessed the occasional migrations of locusts and other predatory insects, will not think this incredible. The ephemeræ live but a few hours, after becoming perfect insects, appearing generally a short time before sunset, flying about in the most irregular manner, rising and descending like gnats, in immense swarms. They emerge from the chrysalis, on the banks of the stream, and make their exit from the envelop or case. A curious circumstance in their history is, that, after the development of the perfect insect, it is incapable of performing the offices of reproduction, until it has regularly moulted for the second time. The skin is found attached to walls, twigs of trees, &c., in the situations where they are common. When at rest, these insects preserve the wings in a vertical position, and are found in this position in a semi-torpid state, a short time previous to their death, which follows almost immediately after the impregnation of the female. In the state of larvæ, they are said to live a year, and in that of the chrysalis or pupa, two years. Respiration is conducted through branchial tufts along the back, and the pupa differs from the larva only in having dorsal appendages, in which the wings are enclosed. One species known to naturalists deviates from the characters of the order in having but two wings, but in other respects corresponding to its brethren.

EPICRANIUM. The skull-cap of an insect. It constitutes the greater part of the exterior of the head, but chiefly occupies the upper and the hinder parts.

EPIDEMIC DISEASES. Diseases which, at any one time, have an extensive prevalence, and attack many animals of a species. The epithet epidemic signifies "upon the people," and properly designates prevailing distempers among human beings; and the epithet epizootic signifying "upon brutes," is the corresponding proper designation of prevailing distempers among the lower animals. Yet many writers speak of epidemic diseases in reference as much to brutes as to men. Familiar examples of these diseases are epidemic catarrh among cattle, and foot lameness among sheep.

EPIDENDRUM. A large and most interesting genus of tropical epiphytous plants, of the orchis order. The name signifies "upon a tree," and alludes to the habit of growth. Nearly all tropical orchidaceous epiphytes known in the time of Linnæus and his immediate successors, were regarded as epidendrums; and the group which constitutes the present genus was separated from the rest by Brown and Lindley, and, though very large from additions by modern discovery, possesses well-defined characters. Seventy-one species were enumerated by Lindley in 1831; and nearly as many more were added from discoveries in America before the close of 1840. The genus is both one of the largest and one of the most imposing groups of the ornamental plants of tropical forests and British hothouses; and it comprises two great divisions,—the one bulbous, with either few or many flowered scapes, and the other without bulbs, and with either solitary, aggregate, panicled, or racemose flowers. A notice of the discovery of one species, and a brief description of two other species will convey a fair and somewhat full idea of the whole genus.

Mr. Skinner, the discoverer of a considerable number of the new and very fine species, says, in reference to his discovery of *E. stamfordianum* in 1837, "While detained at Isabal, I quietly took a canoe, and amused myself by a cruise of a few leagues along the shores of the great lake, in search of our favourite orchidaceæ. I returned home drenched to the skin, but happy, nevertheless, in the highest degree; for I have discovered a most beautiful plant, and one which I am perfectly certain is new to you all. It is here called Quartorones, in allusion to the four colours which may be seen in its blossoms; and a more beautiful spectacle than they presented I never beheld. It hung suspended, as it were, over the margin of the lake, and sent forth perfumes that reminded me of the violet, and reached me at a great distance. For twenty minutes I stood gaping at it, before I could prevail upon myself to disturb it; but I found it in such abundance, and such splendid flower withal, that I at length nearly filled my canoe before I could stay my hand, fancying each specimen finer than the one before it."

The onion-rooted species, *E. cepiforme*, was introduced in 1838. Its pseudo-bulb is as large as a peach, smooth, and almost exactly globular; two leaves rise from the apex of the pseudo-bulb, and are linear-ligulate, rather obtuse, about an inch broad and 8 or 10 inches long; a panicle rises from between the two leaves,—ascends, inclusive of the peduncle, to the height of 3 feet or upwards,—and bears copious spreading branches, and numerous flowers; the sepals and the petals are uniform, horizontal, spathulate, acute, and tawny-orange-coloured; and the lip is broadly oblong, channelled, three-lobed, and pale yellowish green, streaked with red veins, and based with a large, fleshy, white disk.—The purple-flowered species, *E. phœniceum*, was introduced from Cuba in 1840. Its pseudo-bulb is large, nearly globular, and very clear and agreeable; its flower-scape is strong, covered all over with minute asperities, and from two to three feet high; its flowers are scentless, and tolerably large, and bloom during two or three months; the sepals and the petals have a light purplish tint, indistinctly mottled with pale green; and the lip is of a delicate pinkish or lilac hue, and has crimson veins.

EPIDERMIS. The cuticle or enveloping membrane of a plant. It coats the root, the stem, the branches, the leaves, the flower, the fruit, and all other parts except the orifices of the spongioles and the summit of the pistils. But, in the root, the stem, and the branches of trees and shrubs, it is a tough and leathery membrane when young, and often a thick and plated crust when old; and in the leaves, the buds, and the flowers, it is a fine film, of not thicker consistence than a cobweb. In the stem and branches of trees, also, it exfoliates, dies, accumulates, drops off, and is renewed; while in herbs, and in all leaves, flowers, and fruits, it neither exfoliates nor is renewed. Except in a dead and crusty state upon trees, it is in itself colourless and transparent, and may be seen to be so by being detached; yet, while remaining upon the plant, it exhibits the colours of the parts beneath it, displaying alike the greenness of the stems and foliage, and the multitudinous tints of the flower and the fruit. It has a different structure upon different species, and displays some remarkable anomalies in a few; yet it may, in general terms, be described as consisting of either a single, a double, or a compound network of fibres, filled up in its meshes with a fine pellicle, and pierced in its centres with minute pores, inflated points, or perspiring and absorbing stomata. See the article ABSORPTION.

EPIGLOTTIS. The leaf-like, heart-shaped cartilage, which is situated at the opening into the windpipe of animals, and which so closes down as to prevent any portion of food or drink from falling into it in the act of swallowing.

EPILEPSY, or FITS. A violent nervous disease in man and in domestic animals. An epileptic horse appears suddenly nonplussed, stares vacantly, trembles, falls, and is more or less convulsed: and, when the fit subsides, he rises, looks astonished, discharges urine, and coolly resumes his usual habits. He ought, if a valuable animal, to be submitted to the treatment of a skilful veterinary surgeon; yet, even though he should seem to become cured, he may possibly be again attacked, and can never be safely used for the saddle. Happily, epilepsy is of rare occurrence among either horses or cattle. When it attacks the latter, its symptoms are nearly the same as in horses; the general cause of it is improper feeding; and the most suitable treatment for it consists of bleeding, purging, and spare diet. Epilepsy sometimes, though not often, attacks sheep,—principally in spring; and if it occasions either severe fits or frequently recurring ones, it may be treated, as in cattle, by bleeding and purging.

EPILOBIUM. See WILLOW-HERB.

EPIMEDIUM. See BARRENWORT.

EPIPACTIS. A genus of perennial-rooted, herbaceous, indigenous plants, of the orchis family. Three species which formerly belonged to it now constitute the genus Cephalanthera; and only four known species now remain. The marsh species, *E. palustris*, occurs in British marshes, grows about 9 inches high, and blooms in July and August; the purpled species, *E. purpurata*, occurs in English shady woods, grows about a foot high, and blooms in June; and the broad-leaved species, *E. latifolia*, occurs in British moist woods, grows about 20 inches high, and blooms in July and August.—Epipactis is also the specific name of a pretty, little, perennial-rooted, herbaceous, umbelliferous, Swiss plant, which some botanists assign to the genus astrantia, and which others make a genus of itself under the name of dondia. The name epipactis signifies "coagulator," and alludes to the coagulating power of the plants upon milk.

EPIPHYLLUM. A genus of splendidly-flowering, evergreen, tender undershrubs, of the opuntia or cactus family. Its characters are more distinct in themselves and more readily recognised by the unpractised eye, than those of any other group of cacti. The name epiphyllum signifies "upon a leaf," and alludes to the protrusion of the flowers from the margin of the leaf-like shoots; and the general appearance of the plants is that of flat, expansive, leaf-like, succulent branches. The well-known and magnificently flowering species, originally called *Cactus speciosus*, *Cactus speciosa*, and *Cactus elegans*, introduced to Britain from Brazil in 1810, and now called *Epiphyllum speciosum*, may be regarded as the type of the epiphyllums. This plant is deservedly one of the greatest and most general favourites of all the cacti; it carries most gorgeous and brilliant red flowers, and is generally about a yard in height; and it comprises two superb English hybrids, Jenkinson's and the brick-red, the former with crimson flowers and the latter with brick-red flowers.—The truncate species, *Epiphyllum truncatum*, formerly *Cactus truncata*, was introduced from Brazil in 1818, has usually a height of only 12 or 14 inches, and may be so treated as to bloom in either summer or winter. "The dwarf habitude of this species, its gracefully half-drooping branches, the singular form, interesting disposition, and admirable tints of its flowers, with their development in the depth of winter, when most succulents are enjoying complete repose, render it an invaluable acquisition to any garden. In its flowers, the whole of the tube and the base of the petals are literally a snowy white, while a band of a vivid purplish hue extends down the sides of the latter, and round the orifice of the tube; the upper portion of the petals being of a most indescribably pleasing purplish tint." Three other species were introduced before the year 1818, and at least eight additional species of hybrids—all very beautiful—are now common in the public nurseries.

EPITHYMUM. See Dodder.

EPIZOOTIC DISEASES. See Epidemic Diseases.

EPSOM SALT,—chemically *Sulphate of Magnesia*. A purgative, saline, chemical compound of magnesian earth and sulphuric acid. It is one of the most common of aperient medicines, and is so very generally known as scarcely to require description. It usually exists in small acicular crystals, and has a very bitter, nauseous, saline taste. It occurs in a natural state, sometimes pure, but far more frequently in combination with gypsum and some other salts. It acquired its popular name of Epsom salt from the circumstance of first having been artificially obtained by evaporation of the water of the medicinal spring of Epsom. It has long been obtained in vast quantities for the druggists from the bittern or brine, which remains after the crystallization of sea-salt; and, for a number of years past, it has also been largely obtained, by a peculiar process, from dolomite or magnesian limestone. Much of the Epsom salt of the shops, particularly of such as has been manufactured from bittern, contains some muriate of magnesia, and is in consequence more or less deliquescent; and an article often sold in the shops under the name of Epsom-salt, consists in a great degree of Glauber salt or sulphate of soda, so crystallized as to have a somewhat similar appearance to sulphate of magnesia. All pure Epsom salt effloresces, is free from deliquescence, and dissolves in its own weight of water at 60° of Fahrenheit. This salt is a valuable purgative, but is often injudiciously and almost blindfoldly administered both to man and to beast. The passion of many of the lower classes for swallowing doses of Epsom salt for almost all sorts of ordinary ailments, is not a little reprehensible; and the free and frequent administration of Epsom salt alike to cattle and to horses, displays mischievous and culpable ignorance of the great difference of constitution in the two classes of animals. It acts well upon the human subject in hypochondriasis, ileus, puerperal fever, and all acute diseases; and it is the best purgative for cattle in almost all sorts of cases; but it can be useful to the horse chiefly as an ingredient in clysters, and sometimes as a cautiously and progressively administered aperient in the commencing stages of fever.

EQUISETUM,—popularly *Horse-tail*. A genus of perennial-rooted, herbaceous, marshy, cryptogamous plants, constituting the natural order Equisetaceæ. They belong to the most highly organized portion of cryptogams or cellulares; and are liable to be mistaken by the unpractised observer for phænogams. They possess a sort of intermediate character between ferns and grasses; and though usually ranked as mere weeds, and often an excessive pest to the farmer on wet soil, they present a very interesting appearance, and, if they were rare exotics, would be regarded by all persons as both curious and beautiful.

Their height varies in different species from about two inches to two yards; their stems and branches are leafless, and regularly articulated; their articulations rise out of tubular sheaths, and may in some instances be easily separated without rupture or fracture; their stems, particularly at the joints, have a hard, flinty epidermis, similar to that of the grasses, and, but for the articulation throughout their structure, might be regarded as culms; and their reproductive organs are in terminal spikes or heads, composed of peltate several-sided scales, producing on their under-surface from four to seven elongated involucres containing the seed. The branches have a verticellate arrangement and a horse-hair-like appearance, and are alluded to in the names equisetum and horse-hair,—the latter being a literal translation of the former; the seeds are remarkable for a hygrometrical movement; and the whole plant was formerly used in medicine as an astringent and a diuretic, and is decidedly, though in various degrees, injurious to cattle. Eight species grow wild in Britain; three have been introduced from Germany and North America; and eight or nine others have been scientifically described. All are artificially propagated by dividing and transplanting the roots.

The winter species, great rough horse-tail, large branchless horse-tail, shave-grass, pewterwort, or Dutch rush, *E. hyemale*, grows naturally in moist, thick, shady woods, but is rare in Scotland, and by no means common in England, and is largely imported for economical purposes from Holland. Its root is black, creeping, and variously branched; its stem is simple, erect, rough, furrowed, cylindrical, deep glaucous green, and usually about 20 inches high; its sheaths are whitish throughout, but black at the base and the summits; and its teeth are small and deciduous. It is eaten by horses, and seems to agree with them; but is disrelished by sheep, and appears to be noxious to cattle. Its dried stems, principally as imported from Holland, have long been used in Britain for cleaning wooden utensils, and polishing cabinet-work, turnery, and metallic wares. This plant might be profitably cultivated for the use of turners, cabinet-makers, and other artificers, in some situations, such as moist ground under trees, and patches of rather light yet good moist soil, which is unsuited to the growth of any more valuable plant.

The corn horse-tail, *E. arvense*, abounds in many wet meadows and moist corn-fields, and is a very troublesome weed on ploughed land, and both a troublesome and a noxious one on pastures. Its root is very branched and creeping; its stems are smooth, cylindrical, pale brown, juicy, and about 6 or 8 inches high; and its fructification is produced in solitary spikes or catkins from the summit of the stems, and appears in March and April. This plant is eaten by horses, but acts mischievously upon sheep, and produces violent diarrhœa in such cattle as are induced by the gnawings of hunger to eat it. It possesses much of the polishing power of the winter species, and is used for cleaning and polishing vessels of tin.

The bog horse-tail or paddock-pipe, *E. palustre*, grows wild in spongy bogs, marshy flats, open drains, and other very wet or spouty situations. Its stem is deeply furrowed, somewhat slender, and usually about 20 inches high; its branches are slender, angular, rough, and minute, and are produced from bottom to top of the stem in whorls; and its fructification is many-spiked, and appears in June and July. This species is as noxious to cattle as the corn species; and, when it establishes itself in drains, it often grows into a matting of roots and stems several yards in length, and totally obstructs the flow of water.

The great river horse-tail, *E. fluviatile*, abounds on the margins and low banks of some rivers, ponds, and lakes. It is by far the largest of our indigenous species, and usually has a height of about 6 feet. Its fructification is a large cylindrical catkin, with four or five pale teeth on a separate short stem, and appears in April and May. Its stems are perfectly erect; and its branches are long and slender, and grow from bottom to top of the stem in whorls. This species is greedily eaten by horses, and appears to yield them agreeable nourishment; and, in some districts of Sweden, it is collected and stored for their use as winter food.

The wood horse-tail, *E. sylvaticum*, grows in moist shady places, particularly by the sides of little rills in woods; but it is not frequent, and does not occasion trouble to farmers. Its appearance is handsome; its stem is erect and about a foot high; and its branches are smooth, slender, angular, compound, whorled, and spreading.—The marsh horse-tail, *E. limosum*, grows in moist woods and marshy watery places. Its stem is stout, very smooth, finely striated, and about two feet high; and its fructification is one-spiked, and appears in June and July.—The variegated horse-tail, *E. variegatum*, grows on the sea-shore and on wet sandy ground in some parts of Scotland and Ireland, but does not occur in England. Its root has remarkably woolly fibres, similar to those of grasses which grow in loose sands; its stem is usually about 6 inches high; its sheaths over the joints are lax and have lanceolate teeth; its catkin is ovate, acute, and black; and its whole appearance is both curious and ornamental.—Drummond's horse-tail, *E. Drummondii*, grows wild on the mountain bogs of some parts of the Scottish Highlands, but is by no means common. Its stem is about a foot high; and its fructification appears in April.

EQUIVALENTS (CHEMICAL). A term employed in chemical philosophy, to express the system of definite ratios, in which the corpuscular subjects of this science reciprocally combine, referred to a common standard, reckoned unity. The principal facts relating to chemical combinations require to be stated, in order to render the present subject intelligible.

And in the first place, leaving out of view the combinations of liquids with each other, and the common cases of solution in water and alcohol, the first law relating to the combination of substances is, that *the composition of bodies is fixed and invariable;* or, in other words, a compound substance, so long as it retains its characteristic properties, always consists of the same elements, united together in the same proportion. Sulphuric acid, for example, is always composed of sulphur and oxygen, in the ratio of 16 parts, by weight, of the former, to 24 of the latter; no other elements can form it, nor can its own elements form it in any other proportion. Sulphate of barytes, in like manner, is always composed of 40 parts of sulphuric acid and 78 of barytes. If sulphuric acid and barytes should enter into combination in any other proportion, some new compound, different from sulphate of barytes, would be formed.

The second law relating to this subject is, that, *when one body combines with another in different proportions, the larger proportion of one of the ingredients has a simple arithmetical ratio to the smaller proportion;*—the second quantity being a simple multiple of the first; and if there is a third or fourth proportion, the same ratio continues between them. The combinations of the two substances, which, in their gaseous state, form, by their mixture, the atmosphere,—oxygen and nitrogen,—unite in five different proportions, and form a good illustration of this law, these proportions having to each other the simple ratio of 1, 2, 3, 4, 5.

	Nitrogen.	Oxygen.
Nitrous oxide consists of .	14	8
Nitric oxide, . . .	14	16
Hypo-nitrous acid, . .	14	24
Nitrous acid, . . .	14	32
Nitric acid, ...	14	40

To give an example from the salts,—the bicarbonate of potash contains twice as much carbonic acid as the carbonate; and the oxalic acid of the three oxalates of potash is in the ratio of 1, 2, and 4. This law is often called *the law of multiples*, or of *combination in multiple proportion.* It has been established only by comparatively recent investigations, but the most rigid researches have abundantly evinced that it is a well-founded law.—The third law of combination is no less remarkable than the preceding, and is intimately connected with it. Water and hypo-sulphurous acid may be adduced for its illustration. The former is composed of 8 oxygen to 1 hydrogen; the latter of 8 oxygen to 16 sulphur. Now, the well-known substance sulphuretted hydrogen is constituted of 1 hydrogen to 16 sulphur; that is, the quantities of hydrogen and of sulphur, which combine with the same quantity of oxygen, combine with one another. Again, 40 parts of selenium, with 8 of oxygen, form the oxide of selenium, and, with 1 of hydrogen, seleniuretted hydrogen; 36 parts of chlorine, with 8 of oxygen, constitute the oxide of chlorine, and, with 1 of hydrogen, form muriatic acid gas; 16 parts of sulphur combine with 36 of chlorine to form the chloride of sulphur. It is manifest, from these examples, that bodies unite according to proportional numbers; and hence has arisen the use of certain terms, as, *proportion*, *combining proportion*, or *equivalent*, to express them. Thus the combining proportions of the substances just alluded to are,—

Hydrogen, ...	1
Oxygen, ...	8
Sulphur, ...	16
Chlorine, ...	36
Selenium, ...	40

When one body combines with another in more than one proportion, then the law of multiples, already explained, comes into action. Thus

	Sulphur.		Oxygen.
Hypo-sulphurous acid is composed of .	16 or 1 pr.	+	8 or 1 pr.
Sulphurous acid, . .	16 or 1 pr.	+	16 or 2 pr.
Sulphuric acid, . .	16 or 1 pr.	+	24 or 3 pr.

The most usual combination is 1 proportion of one body either with 1 or with 2 proportions of another. Combinations of 1 to 3, or 1 to 4, are very uncommon, unless the more simple compounds likewise exist. But this law does not apply to elementary substances only, since compound bodies have their combining proportions, which may likewise be expressed in numbers. Thus, since water is composed of one proportion, or 8, of oxygen, and one proportion, or 1, of hydrogen, its combining proportion is 9. The proportion of sulphuric acid is 40, because it is a compound of one proportion, or 16, of sulphur, and three proportions, or 24 of oxygen; and, in like manner, the combining proportion of muriatic acid is 37, because it is a compound of one proportion, or 36 of chlorine, and one proportion, or 1, of hydrogen. The proportional number of potassium is 40, and as that quantity combines with 8 of oxygen to form potash, the combining proportion of potash is 48. Now, when these compounds unite, one proportion of the one combines with one, two, three or more proportions of the other, precisely as the simple substances do. The hydrate of potash, for example, is constituted of 48 potash and 9 of water, and its combining proportion is, consequently, 48+9, or 57. The sulphate of potash is composed of 40 sulphuric acid + 48 potash. The combining proportion of this salt is, therefore, 88. The muriate of the same alkali is composed of 37 muriatic acid + 48 potash; its combining proportion is, therefore, 85. The composition of the salts affords an excellent illustration of this subject; and, to exemplify it still further, a list of the proportional numbers of a few acids and alkaline bases is subjoined.

Fluoric acid, . .	10	Lithia, . .	18
Phosphoric acid, .	28	Magnesia, .	20
Muriatic acid, . .	37	Lime, . .	28
Sulphuric acid, .	40	Soda, . .	32
Nitric acid, . .	54	Potash, . .	48
Arsenic acid, . .	62	Strontia, .	52
		Barytes, .	78

Now bodies uniting according to their proportional numbers, as has been seen above, the proportion of each base expresses the precise quantity required to neutralize a proportion of each of the acids. Thus 18 of lithia, 32 of soda, and 78 of barytes combine with 10 of fluoric acid, forming the neutral fluates of lithia, soda and barytes, and are termed *equivalents* of each other, as well as of fluoric acid. The same fact is obvious, with respect to the acids; for 28 of phosphoric, 40 of sulphuric, and 62 of arsenic acid unite with 28 of lime, forming a neutral phosphate, sulphate and arseniate of lime, and these acids, in like manner, are equivalents of each other and of lime. These circumstances afford a ready explanation of the fact, that when two neutral salts mutually decompose one another, the resulting compounds are likewise neutral. If 88 parts of neutral sulphate of potash are mixed with 132 of the nitrate of barytes, the 78 barytes unite with the 40 sulphuric acid, and the 54 nitric acid of the nitrate combine with the 48 potash of the sulphate—not a particle of acid or alkali remaining in an uncombined condition. The method of determining the proportional numbers, as might be anticipated from what has gone before, is, to analyze a definite compound of two simple substances which possess an extensive range of affinity. No two bodies are better adapted for this purpose than oxygen and hydrogen, and that compound of these is selected which contains the smallest quantity of oxygen. Water is such a substance; and it is therefore regarded as a compound of one proportion of oxygen to one proportion of hydrogen. But analysis proves that it is composed of 8 parts of the former to 1 of the latter, by which the relative weights of their proportions are determined, that of oxygen being eight times heavier than that of hydrogen. Some compounds are next examined which contain the smallest proportion of oxygen or hydrogen in combination with some other substance, the quantities of each being the smallest that can unite together. Carbonic oxide with respect to carbon, and sulphuretted hydrogen with respect to sulphur, answer this description perfectly. The former consists of 8 oxygen and 6 carbon; the latter of 1 hydrogen and 16 sulphur. The proportional number of carbon is, consequently, 6, and of sulphur, 16. The proportions of all other bodies may be determined in the same manner. Since the proportional numbers merely express the relative quantities of different substances which combine together, it is, in itself, immaterial what figures are employed to express them. The only essential point is, that the relation should be strictly observed. Thus we may make the combining proportion of hydrogen 10; but then oxygen must be 80, carbon 60, and sulphur 160. Dr. Thomson makes oxygen 1, so that hydrogen is eight times less than unity, or 0·125, carbon 0·75, and sulphur 2. Dr. Wollaston fixes oxygen at 10, by which hydrogen is 1·25, carbon 7·5, and so on. According to Berzelius, oxygen is 100. The system of Wollaston becomes the same as Dr. Thomson's by merely dividing by 10; that is, by placing the decimal point more to the left by one figure; and then, if we multiply by 8, it is converted into Mr. Dalton's scale in which hydrogen is the standard.

Tables of the combining quantities of all chemical agents have been drawn up and arranged to guide the chemist in experimental researches. The utility of these tables is very extensive. Through their aid, and by remembering the proportional numbers of a few elementary substances, the composition of a great number of compound bodies may be calculated with facility. By knowing that 6 is the combining proportion of carbon and 8 of oxygen, it is easy to recollect the composition of carbonic oxide and carbonic acid,—the first being 6 carbon + 8 oxygen, and the second 6 carbon + 16 oxygen. 40 is the number of potassium, and potash, being its protoxide, is composed of 40 potassium + 8 oxygen. From these few data, we know at once the composition of the carbonate and bicarbonate of potash. The first is 22 carbonic acid + 48 potash; the second, 44 carbonic acid + 48 potash. These tables are rendered still more useful, if accompanied by a logometric sliding scale, the application of which to this purpose was a happy invention of Dr. Wollaston. As it is not possible to include, on a single scale, the names of all substances, those are selected which are the most frequent subjects of reference. These are arranged in the order of their relative weights, and at such distances from each other, according to their weights, that the series of numbers, placed on a sliding scale, can at pleasure be moved, so that any number expressing the weight of a compound may be brought to correspond with the place of that compound in the adjacent column. The arrangement is then such that the weight of any ingredient in its composition, of any reagent to be employed, or precipitate that might be obtained in its analysis, will be found opposite the point at which its respective name is placed. Let us illustrate its use by a few examples. 1. The quantity of any substance, which is equivalent to a given quantity of any other inscribed on the scale, may be learned by inspection; the quantities taken being quite arbitrary, and such as are liable to suit the purposes at any time. Thus, by bringing 50, on the slider, (in a scale where the weight of hydrogen is expressed by 1), opposite to magnesia, or to its equivalent, 20, it will be seen that 50 parts of that earth are equivalent to 70 lime, 120 potash, &c. 2. It ascertains the quantity of each base that is equivalent to a given quantity of any acid. Thus 50 on the slider being brought opposite to sulphuric acid, or to its equivalent, 40, it appears that 50 parts of this acid saturate 25 of magnesia, 35 lime, 60 potash, &c. In a similar manner, it is capable of indicating the quantities of different acids required to saturate each base; thus 50 parts of magnesia saturate 100 of sulphuric acid, 135 nitric acid, &c. 3. It enables us to determine, by inspection, the proportions of the components in a given quantity of any substance of known composition. Thus, by bringing 100, on the slider, opposite to 72, the equivalent of dry sulphate of soda, we find 55·5 on the slider, opposite to the equivalent of sulphuric acid, and 44·5 opposite to the equivalent of soda; numbers which, together, make up 100 of the salt. It expresses not only the proximate, but the ultimate elements of compounds. Thus, keeping the slider in the same situation as above, we find 22·4 on the slider, opposite to 16, the equivalent of sulphur, and 33·1 opposite to 24, the equivalent of three proportions of oxygen; and 22·4 + 33·1 make up, together, 55·5 of sulphuric acid. By reference to the equivalents of sodium and oxygen, we find, also, that 44 parts of soda are made up of 33 sodium and 11 oxygen. 4. The quantity of any substance required to decompose a given quantity of another, by simple elective attraction, is at once taught by the scale. Thus, if we wish to know the smallest quantity of sulphuric acid adequate to decompose 100 parts of chloride of sodium, by bringing 100, on the slider, opposite to chloride of sodium, or its equivalent, 60, we find 66½, on the slider, opposite to 40, the equivalent of dry sulphuric acid, and opposite to 49, the equivalent of sulphuric acid of commerce, we find 81½ of the latter. We must, therefore, employ 66½ of the former, or 81½ of the latter. Again, to know the quantity of dry sulphate of soda which would result if all the common salt were decomposed, we shall find 120, on the slider, opposite to the dry sulphate, or to its equivalent, 72, and 270 opposite to the crystallized sulphate, or to its representative number, 162. 5. The quantities of salts, each consisting of two ingredients, that are required for mutual decomposition, may be learned by a similar use of the sliding scale. Supposing, for instance, that we have 83 parts of sulphate of potash, and wish to know the quantity of chloride of barium required for their decomposition; bring 83, on the slider, opposite to sulphate of potash, or to 88, its representative, and opposite to 106, the equivalent of chloride of barium; we find 100 on the slider, which is the number required. The results of this decomposition may also be learned by examining the instrument when in the same situation of the slider; for opposite to the equivalent of sulphate of barytes, 118, we find on the slider 111, and opposite to chloride of potassium we find 71·5 on the slider, the two last numbers indicating the resulting quantities of the new compounds. Again, from the weight of a precipitate, it is easy to deduce the quantities of salts which have afforded it. Thus, if we had obtained by experiment 120 parts of dry sulphate of barytes, on bringing that number opposite to its equivalent, 118, we see at once that they may have resulted from 89½ of sulphate of potash, and 108 of chloride of barium; and moreover, that 120 parts of barytic sulphate are composed of 40·6 sulphuric acid, and 79·4 barytes; the sulphuric acid consisting of 16·5 sulphur and 24·1 oxygen, and the barytes of 8·15 oxygen and 71·25 barium. Other applications still, of the scale of chemical equivalents, are pointed out by Dr. Wollaston in his memoir, explanative of its principle and uses, in the Phil. Trans. for 1814; but the accurate and ready solution of so many important practical problems as have been noticed above are sufficient to show its importance to the chemist. Dr. Ure remarks of it, that it is "an instrument which has contributed more to facilitate the general study and practice of chemistry than any other invention of man."

ERAGROSTIS. A genus of exotic, annual grasses, of the glyceria tribe. About a dozen species have been introduced to Britain from the south of Europe, North America, Egypt, and India; and five or six more are known to botanists. All the introduced species have a very handsome appearance; most are about a foot high; three are very tender; and four were formerly assigned to the meadow-grass genus. — Eragrostis is also the specific name of a hardy, ornamental, annual, long-known grass, of the megastachya genus.

ERANTHEMUM. A genus of ornamental, tropical, evergreen undershrubs, of the acanthus family. About a dozen species have been introduced to British hothouses from Guinea, Australia, Nepaul, and the two Indies; and about as many more are known to botanists. The finest of the introduced species is *E. strictum*, an elegant, purple-flowered plant, two feet in height, and blooming in March and April.

ERANTHIS. See Winter Aconite.

EREMACAUSIS. The slow oxidation of the combustible elements of a dead organic body, by exposure to the air. The process formerly shared with changes in living organic bodies the general name of decay; and it was first, and very appropriately, designated eremacausis by Liebig. The changes which occur in it are precisely those of combustion, except that they are slow, gradual, and unaccompanied by flame or by the evolution of sensible heat. Familiar examples of eremacausis are the transmutation of wood into humus, the decay of dead vegetable matter unaccompanied by fermentation, and the formation of acetic acid out of alcohol, or the vinegarizing of liquids containing a large proportion of spirit. "Vegetable juices of every kind, parts of animal and vegetable substances, moist sawdust, blood, &c., cannot be exposed to the air, without suffering immediately a progressive change of colour and properties, during which oxygen is absorbed. These changes do not take place when water is excluded, or when the substances are exposed to the temperature of 32°; and it has been observed that different bodies require different degrees of heat, in order to effect the absorption of oxygen, and consequently their eremacausis. The tendency to undergo this change is possessed in the highest degree by substances containing nitrogen. The conditions which determine the commencement of eremacausis are of various kinds. Many organic substances, particularly such as are mixtures of several more simple matters, oxidize in the air when simply moistened with water; others, not until they are subjected to the action of alkalies; but the greatest part of them undergo this state of slow combustion or oxidation, when brought into contact with other matters already in a state of decay. The eremacausis of an organic matter is retarded or completely arrested by all those substances which prevent fermentation or putrefaction. Mineral acids, salts of mercury, aromatic substances, empyreumatic oils, and oil of turpentine, possess a similar action in this respect. The latter substances have the same effect on decaying bodies as on phosphuretted hydrogen, the spontaneous inflammability of which they destroy. Many bodies which do not decay when moistened with water, enter into eremacausis when in contact with an alkali."

Eremacausis is analogous to putrefaction; but it is much more stubborn in progress, and far more resistive to the play of affinity; for in putrefaction the paramount affinity of carbon for oxygen has immediate and ample scope, being opposed by neither expansion, cohesion, nor the gaseous state, while in eremacausis all these restraints have to be overcome. The carbon of substances under the process of eremacausis is rarely if ever directly acted on by the oxygen of the atmosphere; and in one class of them, no carbonic acid whatever is evolved, while in another such carbonic acid as arises does not result from the play of the oxygen of the atmosphere upon the carbon of the substances. The eremacausal evolution of carbonic acid occurs only in bodies which abound in hydrogen, and is occasioned by a transposition of elements or disturbance of attractions similar to that which evolves carbonic acid in the processes of putrefaction and fermentation. The hydrogen of the bodies combines with the oxygen of the atmosphere, and the carbon and the oxygen of the bodies separate from the other elements, and combine with each other to form carbonic acid. In all non-nitrogenous substances, also, eremacausis invariably precedes fermentation and putrefaction; and not until its slow combustion has to a certain extent proceeded, or till the absorption of a certain quantity of oxygen into the substances has taken place, do the phenomena or symptoms of a fermentative or a putrefactive transformation commence.

ERGOT. A disease in the growing grain or seed of some of the grasses, particularly of rye. It is the most mysterious of all the diseases with which the cereal grasses are affected; and, after multitudinous and most learned investigations, continues to be the subject of conflicting opinions, as to at once its nature, its origin, and its mode of development. The substance called the ergot either issues from between the glumes, and occupies the place of the grain; or it is the grain itself in both a monstrous form and a chemically altered condition. It lengthens to more than double the natural size of the grain, protrudes beyond the chaff, is angled, grooved, and furrowed, has a deep, purplish, brown colour, and often assumes a curved form, somewhat resembling that of a cock's-spur. Its surface, when seen through a microscope, is profusely marked with white, shining, transparent, angular dots; and its interior, when laid open with a sharp instrument, and seen in water under a microscope, appears to consist of white flocculent threads with spherical sporules. It has a spongy texture, a heavy, disagreeable odour, and a nauseous, acrid, burning taste; and when put in contact with the flame of a candle, it catches fire like an oily substance, and burns like an almond. It is supposed by some naturalists to be an excrescence similar to the oak-apple and the nut-gall, and to be occasioned by the puncture of some insect; by others to be a monstrous development or morbid swelling of the seed, occasioned by some disturbance in the organs of circulation or secretion; and by others to be a foreign or superimposed vegetable growth, occasioned by a parasitic fungus. The last of these opinions is probably the best supported; and the kind of minute fungus supposed to occasion it is assigned by De Candolle to the genus sclerotium under the name of *Sclerotium clavus*, but is erected by the Swedish fungologist Fries into a genus by itself under the name of *Spermœdia clavus.*

Ergot, whatever be its origin and its physical nature, exerts a dreadfully noxious power upon the system of any men or brutes who receive even very small portions of it in their food. It has been ascertained by experiment upon many of the lower animals to produce the most horrible gangrenes, rotting of the extremities, internal tortures, and agonizing death; it has been known to slough and kill not a few human beings who have accidentally or inadvertently eaten grain or flour infected with it; and it is supposed to have been the cause of severe and dangerous gangrenous epidemics which have, at various periods, scourged the poor of certain districts of France. It was long supposed to occur only in rye, and to work havoc upon animals chiefly through the medium of rye-flour; but it is now known to infest some maize of South America, and to produce loathsome diseases in mules which feed upon that grain; and it has been recently ascertained to occur with sufficient frequency in the wheat of Britain, to suggest the necessity of caution and investigation. "The ergot," said Professor Henslow in 1841, "is seldom met with in any other corn than rye; and Tessier says he never saw but one example of it in wheat, of which he gives a figure. Bauer also mentions having never found more than two ears of wheat infected by it. I have, however, found it this autumn in four different fields of wheat, and gathered more than a dozen specimens; and I find that some of the farmers here are sufficiently acquainted with it to satisfy me that it must be more common in wheat than has hitherto been suspected. Upon asking my miller to search for me, he very soon picked out about three dozen ergots from two bushels of Revet-wheat, which had been sent to be ground at his mill; and he said that he had left at least as many more in the sample. This wheat was grown in the next parish to Wattisham. A very cursory look into the mouth of a sack of gleaned wheat, then at the mill, also furnished me with three or four more specimens. I would wish to invite agriculturists to make inquiry in their several districts whether the ergot does not sometimes prevail to an extent sufficient to induce a belief that it may be injurious to the health of the poorer classes, whose food is little varied, and who might thus be subjected to whatever evil influence a certain admixture of the ergot in their flour may be capable of producing. It may be also suggested to such medical men as have opportunities of witnessing those disorders to which the poor are more particularly liable, and which are generally ascribed to poverty of diet, whether these complaints may not sometimes be induced or fostered by the presence of this deleterious ingredient in the flour. Tessier states, that some humane proprietors in those districts of France where the gangrenous epidemic was prevalent, were in the habit of furnishing their labourers with rye that had been picked free from ergot, in exchange for any infected samples they might themselves have grown; and that after they had adopted this practice, their labourers were no longer attacked by the epidemic."

Ergot, in the hands of cautious and skilful practitioners, is a very valuable medicine, for rousing weak or exhausted uterine action in cases of prolonged and difficult labour; but it is by far too critical in its proper use, and too dangerous in its misapplication, to be ever safely prescribed by persons of small professional education or of raw and youthful experience. It has also been very beneficially used in cases of difficult parturition in the mare, the cow, and the sheep; yet it ought never to be administered to any of these, especially the cow, except in cases of extremity.

Ergot in rye occurs most frequently in wet and stiff land, and may probably be either much increased by raising the crop on soil which will keep the roots constantly moist, or much diminished by raising the crop on naturally thirsty soil or on land which has been thoroughly subsoil-drained. When ergot has, in any district, been detected in wheat, the health of the whole community loudly demands the thorough draining of every field on which wheat may at any time thence be grown; and when any quantity of ergot is wanted for the druggists, it should be sought by growing rye upon a piece of very wet clay land.—*Medical and Surgical Journal.—Paper by Professor Henslow in Journal of the Royal Agricultural Society of England.—Keith's Botanical Lexicon.—Loudon's Works.—Youatt's Works.*

ERIA. A small genus of splendid, tropical, epiphytous plants, of the orchis family. It is nearly allied to the dendrobiums. Its name signifies "wool," and alludes to the wooliness of its flowers. Three species, the pubescent, the starred, and the rosy, have for 20 or 25 years past had a place among the orchideæ of British hothouses; and all are very highly esteemed.

ERIACHNE. A small genus of grasses, of the sugar-cane tribe. The obtuse species, *E. obtusa*, called by some botanists *Aira truncata*, is a curious, perennial-rooted, hardy plant, of about a foot in height, introduced 47 years ago from North America. Eight or nine other species are known. The name eriachne alludes to the wooliness of the glume.

ERIANTHUS. A genus of curious, reedy-looking, exotic grasses, of the sugar-cane tribe. Nearly 40 species are known to botanists; and two of these, *E. saccharoides* and *E. brevibarbis*, the former about 5 feet high, the latter about 4 feet high, and both hardy, perennial-rooted, and flowering in the end of summer and beginning of autumn, have been introduced to Britain from North America. Both of the introduced species are assigned by Persoon to the sugar-cane genus. The name erianthus alludes to the wooliness of the flower.

ERICA. See HEATH.

ERIGERON. A genus of herbaceous plants, of the thistle division of the composite order. Four species grow wild in Britain; nearly forty have been introduced from foreign countries; and about twenty more are known to botanists. A large proportion are annuals; a few are biennials; three are evergreens, and one of these shrubby-stemmed; and most of the others are hardy, perennial-rooted herbs. Many have a close resemblance to either the fleabanes or the asters; and a considerable number possess more or less of an ornamental character; but all the annual kinds, and some of the perennials, wherever they obtain footing in a garden, prove very troublesome weeds. The greater number are many-flowered and about 12 or 18 inches high; and a considerable number have broad, oblong leaves. Most have purple flowers; and at least a dozen have white flowers.—The sharp species, *E. acris*, is a biennial of the grass lands of England and Scotland, growing to the height of about 20 inches, and carrying blue flowers in July and August. The Canadian species, *E. canadensis*, is an annual of rubbishy and rubbly spots in England, growing to the height of about a foot, and carrying white flowers in August and September. The one-flowered species, *E. uniflorus*, is a perennial-rooted weed of the Scottish Highlands, growing to the height of 3 or 4 inches, and carrying a purple flower in August and September. The alpine species, *E. alpinus*, is a perennial-rooted weed of the mountain rill-beds of Scotland, growing to the height of about a foot, and carrying a purple flower in July.

ERINUS. A genus of ornamental plants, of the figwort tribe. The alpine species, *E. alpinus*, is a pretty little perennial-rooted herb, introduced to Britain upwards of a century ago from the Pyrenees. It has a height of 3 or four inches, carries blue flowers in March and April, and is well adapted for rockwork, and especially for covering and adorning garden walls. When sown in pots, on the borders, or even in rockwork, it is liable to dwindle away or die after flowering; but when sown in the crevices of brick walls, the tops of hothouses, and similar situations, it flourishes with great luxuriance, and produces sheets of flowers. The Spanish species, *E. hispanicus*, has the same origin, height, and habits as the alpine species, but carries red or purplish-red flowers. Three species from the Cape of Good Hope, all small evergreen undershrubs, and flowering in May and June, are sometimes seen in British hothouses; and 8 or 9 other species are known to botanists.—Erinus is also the name of a hardy, annual, pale-blue-flowered campanula, from the south of Europe; and of a tender, evergreen, herbaceous, blue-flowered lobelia, from the Cape of Good Hope.

ERIOBOTRYA. See LOQUAT.

ERIOCAULON. See PIPEWORT.

ERIOCEPHALUS. A genus of ornamental, evergreen, Cape-of-Good-Hope shrubs, of the chamomile division of the composite family. A species introduced to Britain upwards of a century ago, and described by Miller, has a bushy stem of 3 or 4 feet in height,—many side branches,—thickly set, clustered, woolly leaves, some entire and tapering, and others digitate with 3 or 5 lobes,—and tubulous flowers, standing erect, in small clusters, at the extremity of the branches. The leaves of this species, when bruised, emit a strong fragrance similar to that of lavender cotton. Five species are at present cultivated in British greenhouses.

ERIODENDRON. A genus of tropical, evergreen timber-trees, of the silk-cotton-tree tribe. The Guinea species, *E. guineense*, was introduced about 20 years ago to the hothouses of the botanic gardens of Britain. It usually attains in Guinea a height of about 160 feet.—The Caribbean species, *E. caribæum*, was introduced to Britain upwards of a century ago. It usually attains in the West Indies a height of about 75 feet. — Two other introduced species, and virtually the character of the whole genus, are noticed in the article BOMBAX.

ERIOGONUM. A genus of handsome, hardy, perennial-rooted, herbaceous plants, of the polygonum tribe. Four species, the woolly, the silky, the long-leaved, and the few-flowered, were introduced to Britain from North America during the 12 years succeeding 1810; and all are propagated from seed, and make a fine appearance in the flower-border. The woolly is white-flowered, and the other three are yellow-flowered; the silky is about a foot high, and the other three are from 20 to 30 inches high.

ERIOPHORUM. See COTTON-GRASS.

ERIOSOMA. See APHIS.

ERIOSPERMUM. A genus of tuberous-rooted, Cape-of-Good-Hope plants, of the asphodel tribe. Eight species, all summer-bloomers, and attaining a height of about a foot, were introduced to Britain during the 30 years following 1794; and three of these, the woolly, the wonderful, and Bellenden's, have an ornamental character. The name eriospermum signifies 'woolly seed,' and alludes to the wooliness of the pericarp.

ERIOSTEMON. A genus of ornamental, evergreen, Australian shrubs, of the rue tribe. About a dozen species, chiefly red-flowered, and two or three feet high, were introduced to Britain during the 12 or 13 years following 1821. The name eriostemon signifies 'woolly stamen,' and alludes to the fringedness of the staminal filaments. All the species are beautiful; and most bloom from April till August.

ERMINE. See STOAT.

ERMINE MOTH,—scientifically *Yponomeuta Padella*. A mischievous lepidopterous insect, of the yponomeutidous family of moths. It makes great devastations upon shrubs and fruit-trees, and is a very special pest during the whole of its caterpillar condition. The perfect insect measures nearly an inch from tip to tip of the expanded wings; and its upper wings have a leaden grey colour, with about 30 black spots nearly in regular longitudinal rows; while its lower wings have a darker leaden colour, with thick fringes. Different varieties and individuals of the species, however, exhibit much diversity of colour; some having the ground of the anterior wings white; others having the costa livid, and the inner margin white; others having a livid or pale lead-coloured central cloud; others having nearly all the surface of a pale or deep lead colour; others having almost every conceivable shade of intermediate colour; and others considerably differing in the number of their spots. The insects are so conspicuous partly from their colours and partly from their numerousness, that, when either wheeling about trees, flying across hedges, or resting upon branches, they often challenge notice, and are seen by the most careless observers. The caterpillar has a brown head, and a smooth, greyish body, dotted along each side with a row of black spots. About the end of July, the female deposits her eggs on the branch of some bird-cherry, apple-tree, plum-tree, cherry-apple, pear-tree, white-thorn, black-thorn, or similar plant; and spreads over them a gummy coating, about one-eighth of an inch in diameter, and of such a nature as to screen and defend the young caterpillars. When the leaves are expanding from the leaf-buds in the following spring, the caterpillars creep from beneath their gummy covering, ensconce themselves in the interior of the leaves, and feed upon the cellular tissue, leaving for a time the epidermis untouched; and when they attain a considerable increase in size, they eat their way through the epidermis, and disclose themselves to the view of the observer. "Up to this period, the leaves have a brown appearance, caused by the caterpillars eating up the inner portion; but now the caterpillars are observed in thousands upon the leaves, and the gardener who saw nothing of them when they were inside the leaves yesterday, persuades himself that they have fallen down in a shower, or have been blown from some distant country." The caterpillars keep together in large societies, spin a common net or web over the neighbouring twigs or shoots, eat the upper sides of the leaves which are beneath the net, and then go off to another branch or set of twigs and repeat the process. Each of the societies of caterpillars makes five or six nets, and a corresponding number of devastations and removals; so that against midsummer, the trees infested with them, comprising perhaps a large proportion of an entire orchard, are leafless, and exhibit in lieu of foliage a sheeting of the insects' webs.

In the summer of 1837, these caterpillars abounded on the apple-trees at Walworth, and many other places in the vicinity of London; and they were also exceedingly numerous, and committed extensive devastation, in the neighbourhood of Paris. "At the commencement of the month of July last," said Mr. Westwood in the autumn of that year, "I observed this devastation carried to a lamentable extent in the apple-trees with which the road-sides between Abbeville and Paris are planted, and which for miles were completely defoliated. The branches were covered with webs, and not the least portion of green was to be seen; the webs were suspended from the branches in festoons reaching to the ground, which, beneath the tree, appeared carpeted with silk, in so remarkable a manner as to attract the attention of the most incurious passenger. Some kinds of apples, however, as well as the pear trees, escaped; and this fact, depending upon the nice discrimination in the taste of the insects, might be beneficially employed by inducing the planting of those varieties which appear to be most unpalatable to these destructive creatures."

When the leaves of a tree show by their brown or burnt appearance that they have been entered and are being interiorly devoured by the young caterpillars, they ought to be picked off and burnt; and when webs have been formed, they ought to be cautiously picked off with their enclosed societies of caterpillars, and carefully destroyed. Or if either inhabited leaves or live webs be too numerous to be dealt with by the slow process of hand picking, they may be deluged, or at least destructively saturated, with either soap-suds or an infusion of ivy thrown up by means of a garden engine.—About the end of June, whole societies of the caterpillars suddenly and simultaneously pass into the state of chrysalides, and, continuing to be social or to lie close to one another under their webs, form masses somewhat similar to those of ants' "eggs" or coccoons, but considerably larger. The chrysalides are enclosed in long cylindrical coccoons of white silk; and in about 20 days, the moths emerge with moist and unexpanded wings from the ends of the coccoons, and, after resting a little time, expand their wings and fly. The simultaneous appearance of the moths may readily draw the attention of the gardener or the orchardist; and the moist and useless state of their wings during their period of rest, affords him an excellent opportunity of easily beating or shaking them from the branches into a sheet spread upon the ground, and so effecting their destruction.

EROPHILA. A small genus of handsome, little, hardy, white-flowered annual plants, of the cruciferous order. It has a close affinity to the genus draba. The common species, *E. vulgaris*, grows wild on walls in Britain, is about 3 inches in height, and blooms in March and April. Two species, the early and the American, have been introduced from the Caucasus and North America; and two other species are known to botanists. The name erophila signifies "lover of spring," and alludes to the time of flowering.

ERSH. Fresh stubble land. But the name is provincial.

ERUCA. See Rocket.

ERVUM. See Tare and Lentil.

ERYNGO,—botanically *Eryngium*. A genus of ornamental herbaceous plants, of the umbelliferous order. The sea species or sea-holly, *E. maritimum*, is a perennial-rooted native of the sandy and gravelly shores of Great Britain and Ireland. Its root is whitish, is mucilaginous, has a pungent aromatic flavour, and is long and creeping, and strikes 18 or 20 inches deep into the soil; its stem is smooth and about 15 or 18 inches high, and divides upwards into two or three branches; its radical leaves are stiff, three-lobed, spinous, and more or less sheathing; its stem-leaves are similar in form to the radical leaves, but smaller, and are also sheathing; its flowers have a whitish blue colour, and are produced at the ends of the branches in roundish prickly heads, and bloom from July till October,—and under each is a range of narrow, stiff, prickly leaves, spreading like the rays of a star. The whole plant is smooth and glaucous, and has a beautiful bluish tint. The roots have the reputation of being stimulating and restorative, and are used both in decoction and in a candied form.—The field eryngo, *E. campestre*, grows wild on the pastures of some parts of Britain,—and particularly on waste grounds near the sea; but it is considerably more rare than the sea-holly. Its form is at once bushier, taller, and more slender than that of the sea-holly; its radical leaves are larger; its general tint is more of a glaucous green; and its flowers have a white or purplish colour, and bloom in July and August. Both this species and the sea-holly are occasionally cultivated as economical plants.—Upwards of 30 species have been introduced from continental Europe, North America, and other parts of the world; and between 20 and 30 additional species are known to botanists. Nine or ten of the introduced species are tender evergreen herbs; and most of the others are hardy perennial-rooted herbs.

ERYSIMUM. See HEDGE-MUSTARD.

ERYSIPELAS, or WILD FIRE. An inflammatory disease of the skin of animals. It somewhat frequently attacks sheep, assumes the character of an epizootic, exhibits considerable resemblance to the disease called red water, and is much more violent than ordinary or even very bad kinds of scab. It makes its attacks suddenly, and, if not promptly and vigorously attended to, spreads with great rapidity among the flock. It usually appears in August and September, and seldom continues longer than eight days at a time. It is attended with excessive itchiness, and causes small blisters, which are full of a red and watery fluid, and which, after breaking, are followed by blackish-coloured scabs. An affected sheep should be placed in a field away from communication with the flock, receive some gently aperient medicine, be washed with goulard water or lime water, and receive some sulphur electuary, and if that fail, some sulphur and saltpetre.

ERYSIPHE. See MILDEW.

ERYTHRÆA. A genus of small, low-growing, ornamental, herbaceous plants, of the gentian family. It has a close relationship to the chironias. Its best known species—ranked by some botanists as a chironia—is the subject of our short article CENTAURY. The broad-leaved species, *E. latifolia*, grows wild on the sea-shores of some parts of Britain, has a height of 5 or 6 inches, and carries pink-coloured flowers in July and August. The fair or pretty species, *E. pulchella*, called by Smith *Chironia pulchella*,—and the sea-side species, *E. littoralis*, called by Smith *Chironia littoralis*—grow wild on the coasts of some parts of England, have a height of about 3 or 4 inches, and carry pink flowers, the former in August and September, and the latter in June and July. All these three native species are annuals. Six or seven species, variously annual, biennial, and perennial, have been introduced from abroad, chiefly as ornamental plants; and about a score of other species are known to botanists.

ERYTHRINA, — popularly *Coral - Tree.* A genus of tender and superbly flowering plants, of the kidney-bean division of the leguminous order. Nearly 40 species have been introduced to Britain; and three of these are stemless, and consist of large, perennial, woody roots, and annual leafy branches and flowering racemes, while the others are either shrubs or small trees, bearing leaves and flowers on their stems or boughs, and possessing the habit of either evergreens or subevergreens.—The herbaceous species, *E. herbacea*, was introduced from Carolina in 1724. Its root is woody and very large, and seldom rises more than a foot from the surface; annual shoots grow from the crown of the root in spring, and rise to the height of about two feet; the leaves are trifoliate, of a deep green colour, and shaped like the point of an arrow; and the flowers have a scarlet colour, are produced in long spikes from the top of the shoots, and appear from June till September; and though each flower has five petals, it appears at a little distance as if it were monopetalous, the upper petal being much longer and larger than the other four.—One of the longest known of the dendritic species, was introduced from the West Indies before the close of the 17th century. Its stem attains a height of 10 or 12 feet in our hothouses, and of 20 or 24 feet in its native country; its bark is brown; its branches are numerous, irregular, and strong; its leaves are trifoliate, and stand on long footstalks; its leaflets are smooth, heart-shaped, and deep green, —and the middle one is much larger than the other two; and its flowers grow in short, thick, close spikes at the end of the branches, appear in May and June, and have a deep scarlet colour and a very imposing appearance. The leaves decay and fall in spring, exfoliate in autumn, and are in their prime during winter; so that, in the summer season of the plant's floral glory, it is leafless.—Excepting one pink-flowered and one pale-scarlet-flowered, all the species are deep-scarlet-flowered; and while all are eminently ornamental, some—especially of those introduced since the commencement of the present century —are exceedingly brilliant, and deservedly occupy a prominent place in all good collections, whether large or small, of tender shrubby plants. Some of the most splendid are *E. umbrosa* or *E. arborea*, 80 or 90 feet high, introduced from the Caraccas; *E. Christa-galli*, 40 or 50 feet high, from Brazil; *E. macrophylla*, 20 feet high, from Teneriffe; *E. mitis*, 20 feet high, from the Caraccas; *E. poianthes*, 20 feet high, from South America; *E. rubrinervia*, 20 feet high, from Bogota; *E. velutina*, 20 feet high, from the Caraccas; *E. indica*, 20 feet high, from India; *E. arborescens*, 30 or 35 feet high, from India; *E. piscidioides*, 16 feet high, from India; *E. incana*, 12 feet high, from India; *E. abyssinica*, 10 feet high, from Abyssinia; *E. secundiflora*, 20 or 25 feet high, from Brazil; *E. fulgens*, 12 feet high, from India; *E. spathacea*, 16 feet high, from the West Indies; *E. suberacea*, 16 feet high, from India; and *E. laurifolia*, 4 feet high, from South America.

Erythrinas, while among the most gorgeous plants of the garden, are usually regarded as so shy and fastidious as to be necessarily confined to greenhouses which enjoy the care of very skilful gardeners. But though nearly all require to be renewed from seed, and are troublesomely nice in the embryo stages of their development; yet the most ornamental kinds may be annually propagated from stock-roots with nearly as much facility as dahlias, and might, at a cheap rate, be made abundant in all ordinarily good gardens. "As soon as the plants have done flowering, (or even plants that have not flowered at all, but which have ripened their wood well, will answer the same purpose,) cut them down, and make as many cuttings of the stems as there are buds, preserving, if possible, the leaf, or rather the three leaves, to each bud; and if the buds are opposite each other, as is sometimes the case, the stem may be split, if near the bottom, where the wood is hard and well ripened, for this part of the stem will root even without the assistance of the foliage. Having prepared the cuttings, plant them separately in small pots, with the eye or bud just below the surface of the mould, which should be light and sandy, the piece of the stem which forms the cutting being laid flat; then immediately place them under a hand-light on a strong bottom heat, so that the heat under the glass may range from 75° to 80° Fahrenheit, shading regularly when the sun is likely to scorch them, or dry up the moisture, for they should be kept constantly well watered. In three weeks, they will be rooted, when they may be gradually hardened, till they will bear a shady part of the stove. Thus from every single stem no less than from twenty to thirty plants may be annually reared; and if the flowering plants are forced, so as to make them flower twice a-year, double that number may be obtained." Plants in pots, if they have a rich soil, abundance of water, plenty of pot-room, and a moist atmosphere, will seldom fail to flower freely; and during the period of their dormant condition, they should be kept perfectly dry. In warm situations, and on tolerably well-drained soil, Erythrina Christa-galli will live in the open ground through winter, without any other protection than a covering of soil or sawdust over the crown. In 1845, a plant of this species, in the open border, on sandy soil, in a sheltered situation, at Babworth, had 45 flowering-stems of from 4 to 4½ feet high.

ERYTHROGEN. A peculiar chemical element of the animal system, supposed to constitute, in combination with nitrogen, the colouring matter of the blood. It is green, transparent, tasteless, and of a similar odour to phosphuretted hydrogen. It seems to have been first obtained from the gall-bladder of a person who died of jaundice; yet it does not occur in bile or in any other of the animal fluids.

ERYTHRONIUM. See Dog's-Tooth Violet.

ERYTHROXYLON. A genus of tropical trees and shrubs, constituting the type of the natural order Erythroxyleæ. Only four species of this order have been introduced to Britain,—three belonging to the genus erythroxylon, and one to the genus sethia. The plants of the order have some affinity to the Barbadoes cherry-trees, but differ somewhat from them in habit, and possess albumen and scaly-based petals. Two of the introduced species of erythroxylon are evergreen timber-trees of the Mauritius, naturally growing to the height of from 40 to 60 feet; and the other is a large evergreen shrub from Havannah. Upwards of 20 other species are known to botanists. The wood of *Erythroxylon areolatum* is so red and fragrant, that the inhabitants of some parts of India use it instead of sandal-wood; and its leaves and young shoots are supposed to possess cooling properties, and are prepared with fine oil into a refreshing liniment for the head. The name erythroxylon signifies "red-wood," and is descriptive of the timber.

ESCALLION. See Onion.

ESCALLONIA. A genus of tender, ornamental, evergreen shrubs, constituting the natural order Escalloniæ. They are chiefly natives of Chili; they bear terminal racemes of small red or white flowers; and they are nearly related to the andromedas, and closely resemble them in habit. Six or seven species were introduced to Britain between 1819 and 1838.

ESCALOT, or Eschalot. See Shallot.

ESCHSCHOLTZIA. See Chryseis.

ESCULENT. Any plant whose root, stem, shoots, leaves, or other bulky parts, are suitable food to man. Familiar examples of esculents are carrots, turnips, and all our common kitchen vegetables.

ESCULUS, or Quercus Esculus. The Italian beech. See the article Oak.

ESPALIER. A trellis or rail-fence for the support and training of outspread fruit-trees. It exposes the trees to a full play of light, protects them from fracture by strong winds, promotes the earliness of their fruiting, economizes space, and greatly contributes to a general appearance of neatness and decoration. Espaliers are erected sometimes close to walls, but more commonly in detached positions; and they have a powerfully ornamental effect, and at the same time serve for the protection of half-tender vegetables, when interposed between the central plots and the flower-borders of kitchen-gardens. Most espaliers in former times were made either of ash-poles or of square long timbers of fir; but now many are made of any sort of wood which can be most economically obtained, some of wire and wood, some of cast-iron, and the best of young larch, obtained in the thinning of plantations. Espaliers are sometimes double, so as to afford two surfaces for training. Two infrequent varieties of espalier, differing widely in form from the fence or trellis espalier, but thoroughly identical with it in principle, are the table-rail and the bush-trellis. In the table-rail, the tree acquires a given height of stem, and is then trained athwart a horizontal surface or table-like expanse of rails; and in the bush-trellis, its branches are trained spirally round the outside of a circle of stakes. The kinds of trees most commonly trained on espaliers are apple-trees, pear-trees, and plum-trees.

ESPARCET. A provincial name of sainfoin.

ESSE. A provincial name of ashes.

ESSENTIAL OILS. This name is applied to those volatile fluids usually obtained from aromatic plants, by subjecting them to distillation with water. The oil is volatilized with the aqueous vapour, and is easily condensed; a small portion of it is retained in solution by the water; but the greater part separates, and is obtained pure from the difference in their specific gravity. In some instances, as, for example, in the rind of the orange and lemon, the oil exists in distinct vesicles, and may be obtained by expression. The principal volatile or essential oils are those of turpentine, aniseed, nutmeg, lavender, cloves, caraway, peppermint, spearmint, sassafras, chamomile and citron. The taste of these oils is acrid and burning; and their odour very pungent, generally resembling the taste and smell of the vegetables affording them. They are generally fluid, and remain so even at a low temperature; but some congeal at a very moderate degree of cold, and others are naturally concrete. They are extremely volatile, and boil at a temperature considerably above that of boiling water; thus oil of turpentine boils at 315°. They are very soluble in strong alcohol, but, on adding water largely, are precipitated. They are soluble in ether in like manner, but do not form soaps with the alkalies, by which they are distinguished from the fixed oils. They are readily inflamed by strong nitric acid; especially with the precaution of adding a little sulphuric acid to render the former more concentrated. Exposed to the action of the air, they undergo an alteration in consequence of the absorption of oxygen, become thickened, and gradually change into a solid matter, resembling the true resins. When digested with sulphur, they unite with it, forming what have been called *balsams of sulphur*. One of the most useful and abundant of the essential oils is that of turpentine, commonly called *spirit of turpentine*. It is obtained by distilling turpentine and water, in due proportions, from a copper alembic. It is perfectly limpid and colourless, has a strong smell, a bitterish taste, boils at 316°, and is extremely inflammable. It is the solvent employed in making a variety of varnishes; but for purposes of nicety, it requires to be rectified by a second distillation. In general, the volatile oils are used in the practice of medicine, or as perfumes. Those applied to the latter use, as the essence of rose, of jasmine, violet, &c., are possessed of a more feeble odour, and, being obtained from the flowers of their respective plants, require much care in their preparation. This is done by spreading upon white wool, impregnated with olive-oil, the petals of the flowers, and leaving them for some time, covered over with a woollen cloth, upon which flowers are also scattered. The flowers are renewed from time to time, until the olive-oil employed appears to be saturated with the oil of the flowers, when this last is separated by digesting the wool in alcohol.

ESTATE, in Law. The title or interest which a person has in lands, tenements, hereditaments, or other effects, the word being derived from the Latin *status*, which means the condition or circumstance in which a person stands in regard to his property. Estate is real or personal. The phrase *personal estate* is applicable not only to moveables, goods, money, bonds, notes, but also to some fixtures temporarily attached to lands or buildings; and the distinction between those fixtures which are temporarily such, and those which belong to, and form a part of the house, or other real estate, is of importance, as this distinction will determine how it is to be attached on mesne process, or seized and sold, or set off on an execution, and also how it descends on the decease of the proprietor. But personal estate also applies to some interests in lands or houses; thus a lease of them for a certain number of years, though it be more than a hundred, and so longer than any person is likely to live, is personal estate; and yet an estate for the life of the owner, or of any other person, in these subjects, though the person, by whose life the interest is limited, may be ever so old or infirm, and likely to survive ever so short a time, is real estate, and is subject to the law regulating such estate, in regard to sales and descents. Real estate in lands is of various kinds and descriptions, according to the quantity of interest, its duration, or the time by which it is limited in respect to its commencement or termination, and the number and condition of the owners. A *fee simple* is the amplest estate which the law admits of. A *freehold* is an estate for the life of any person or persons, or any greater estate. An estate in tail is one limited to certain heirs. Only real estate and a freehold greater than for the life of one person, can be entailed; but such an estate is of various kinds, such as *tail-male*, where it descends in successive order to the male heirs of the grantee in direct descent; *tail-female*, where it is thus limited to the female descendants: if it goes in successive order to his descendants without any distinction, it is called an estate in *tail-general;* if it is limited to certain descendants, as the children of a certain wife, it is an estate in *tail-special*. An estate in *remainder* is one of which the owner is to come into possession after the expiration of an intermediate estate of another person, or number of persons or heirs; and so also is an estate in reversion: thus, if one grants an estate tail, this estate tail may expire, in which case the lands will come back or revert to the grantor, and his estate, which still remains to him after he has granted the estate tail, is therefore called a *reversion*. As to the number of owners, an estate *in common* is a freehold belonging to more than one proprietor, in undivided shares; and so also is an estate in *joint-tenancy;* but there is this distinction between these two kinds of estates, that when one joint-tenant dies, his share goes to the other joint-tenants, which is not the case in tenancies in common. An estate in *coparcenary* arises when an estate in fee simple descends, on the decease of the owner, to his daughters, sisters, aunts, or female cousins, or their representatives, being females; and they are called *coparceners*, or, for brevity, *parceners*. Real estate left to any one by will is called a *devise*, or an estate *by devise*, in distinction from a bequest of personal property, which is called a *legacy*.

ESTRAYS and WAIFS. Estrays are any valuable beasts, not wild, found within a lordship, and whose owner is not known, such as are commonly impounded, and not claimed. They are then to be proclaimed in the church and two nearest market towns, on two market days, and, not being claimed by the owner, belong to the king, and now commonly, by grant of the crown, to the lord of the manor, or the liberty.—*Waifs* are goods which are stolen, and waved, or left by the felon on his being pursued, for fear of being apprehended, and forfeited to the king or lord of the manor.

ETHER. A volatile and inflammable liquid, formed by heating a mixture of alcohol and some one of several acids. The only ether for a long time known to chemists, and that still called ether par excellence, is sulphuric ether, resulting from a mixture of alcohol and sulphuric acid. The theory of its formation has been much disputed among chemists, and is still somewhat obscure. The liquid is perfectly limpid and colourless, and has a peculiar, fragrant, searching odour, and a hot, pungent, and somewhat spirituous taste. It is more volatile than any other known liquid, almost instantly evaporates from a finger dipped in it, and produces a strongly refrigerating effect by its evaporation. It acts upon the animal system externally as a stimulant and refrigerant, and internally as a stimulant, an antispasmodic and a narcotic; but, though considerably used in human medicine, it has been very slightly, if at all, introduced to veterinary practice.

ETHIOP'S MINERAL. See ÆTHIOP'S MINERAL.

ETIOLATION. A morbid loss of verdure in plants. It renders the parts affected by it pale and sickly; and is variously caused by poverty of soil, in not yielding proper nourishment,—by the nestling or gnawing of insects in the roots, so as to debilitate the plant, and render it insensitive to light,—and by seclusion or shading in dark rooms, in the fissures of rocks, or under the shade of trees, so as to avert the play of light or the requisite evolution of oxygen. Artificial etiolation is effected for some purposes of garden culture, and constitutes the well-known process of BLANCHING.

EUCALYPTUS. A large and most interesting genus of Australian evergreen trees, of the myrtle family. They are exceedingly abundant in most parts of both New Holland and Van Diemen's Land; they are both the largest and the most conspicuous trees in many of the Australian forests; they constitute, jointly with the leafless division of the acacias, the characteristic vegetable features of a very large proportion of Australian sylvan scenery; and they are so generally diffused, so thoroughly interspersed with whatever meets the eye, as to present some one or more of their species to a traveller's view at almost every step of his progress through the native districts. They grow with amazing rapidity; and, in many instances, attain enormous magnitude. Their trunks have often a girth of from 25 to 50 feet, and sometimes become so hollow as to be used for arbours and tombs; their timber is worked with surpassing ease, but soon becomes as hard as oak, and in consequence is of supereminent value for multitudes of economical purposes; their bark is, in many instances, so exceedingly hard as to have won for itself from the colonists the name of iron-bark; and their leaves are dotted, and vary in character with both the age and the situation of the trees, and grow in the reverse position to those of almost all other plants, presenting their edge to the sky, and both their surfaces to the equal play of the sun's rays. Loudon reckons 55 species to have been introduced to Britain between the years 1794 and 1820; and exhibits 21 of these as timber-trees, and 34 as ornamental plants. But the whole genus is really in a state of utter botanical confusion; and, in consequence of the mutation of characters in the same species and even in the same individual, it probably will not be reduced to clear specific classification till some skilful botanist enjoy prolonged opportunities of observing it in its native country. Most of the kinds introduced to Britain are hardier than the common myrtle, grow freely in any soil, and are easily propagated from cuttings; and though killed down to the ground in the open air in winter, they usually shoot up again in spring; and some give promise of being capable, in the south of England and the south of Ireland, of attaining the size of forest trees. All the species yield, in their native country, a copious exudation of an astringent, gum-like juice, somewhat similar to gum kino; and, on this account, they are generally known among the colonists by the name of gum-trees. The readiest mark, and a very distinctive one, by which they are known in Britain, is the spottedness of their leaves.

EUCHARIDIUM. A genus of hardy, ornamental, annual plants, of the order onograriæ,—that to which the fuschias and the clarkias belong. The neat species, *E. concinnum*, was introduced in 1836 from North America; it is purple-flowered and about 9 inches in height; and it possesses the recommendation of being a very long time in bloom. The large-flowered species, *E. grandiflorum*, is similar to the neat in both height and colour.

EUCHLORINE. The protoxide of chlorine. It is obtained by the action of muriatic acid on chlorate of potash.

EUCOMIS. A genus of ornamental, evergreen, herbaceous, Cape-of-Good-Hope plants, of the asphodel family. Seven species were introduced to the greenhouses of Britain, in the course of last century; and most of these have green flowers, and are about two feet high. The name eucomis signifies "handsome-hair," and alludes to the hairily-tufted crown of the flower-spikes.

EUDIOMETER. An apparatus for analyzing atmospheric air and other gaseous mixtures. Dr. Hope's eudiometer, as improved by Dr. Henry, consists of a bottle of elastic gum, a well-ground side stopper, and a graduated vertical tube; and it effects analysis by filling the tube with the gas to be analyzed, by filling the bottle with a solution of hydro-sulphuret of potash or any other liquid substance capable of absorbing the oxygen or other element to be withdrawn from the gas, and by withdrawing the stopper under water, when a quantity of liquid rushes into the tube tantamount to the quantity of the gaseous element absorbed. A notion was originally ascertained that this instrument would indicate the degree of salubriousness in the air of any place, by ascertaining its proportion of oxygen; but since evidence has been obtained that the proportion of oxygen in all parts of the atmosphere is strictly or very nearly uniform, and that insalubriousness of air is caused by the presence of foreign elements in the atmosphere, this notion is untenable.

EUGENIA. A large and interesting genus of ornamental and fruiting evergreen, tropical trees and shrubs of the myrtle tribe. About 200 known species were formerly assigned to it; but a large proportion of these, including the clove-tree, the Jamaica pepper plant, the Malay apple-tree, the Jambos fruit-tree, and some others of high interest, are now distributed among other genera. About 90 known species are still retained in the genus eugenia; and about one-third of these have been introduced to the hothouses of Britain. The eugenias have a close resemblance, in both habit and general appearance, to many myrtles. The timber of most is useful and good; their bark abounds in tannin; their soft parts contain a warm volatile oil; and the fruit of some, though rendered somewhat disagreeable by the aroma of the oil, are edible. Nearly all the introduced species have white flowers; most vary in height from 4 to 26 feet; and those which rank as fruiting plants are *E. sinemariensis*, *E. macrocarpa*, and *E. javanica*. All are beautiful; and some possess fully more attractions when in fruit than at any other season. *E. australis* deserves a place in every greenhouse; its foliage has a deep green colour; its fruit grows in the utmost profusion, and varies in colour from a deep crimson to a pure white; and the whole plant, sheeted with both foliage and fruit, is an imposing object both by daylight and by candlelight in winter.

EULOPHIA. A genus of tuberous-rooted and epiphytous ornamental plants, of the orchis family. The long-spiked species, *E. macrostachya*, is a native of the shady woods of Ceylon, and was introduced to Britain in 1836. Its stem is a long, irregular, erect cone; it is analogous to the pseudo-bulbs of the majority of orchidaceæ, and to the horizontal tuberous rhizomata of such species as yield a kind of salap; and, when old, it is covered with the withered and ragged remains of leaves. Its flowers have a combination of green and yellow colours, and grow in graceful racemes, and bloom in great profusion from June till December. This is one of the most easily cultivated of all the orchidaceæ.—Mackay's species, *E. Mackaiana*, called by Hooker *Zygopetalum Mackai*, and introduced from Brazil in 1825, is a gorgeous plant. The Guinea species, *E. guineensis*, introduced from Sierra Leone in 1822, and exhibiting a predominance of pink colour in its flowers, displays great beauty. About a dozen other species have been introduced, principally from the Cape of Good Hope.

EUNOMIA. A small genus of herbaceous plants, of the cruciferous order. The opposite-leaved species, *E. oppositifolia*, called by some botanists *Lepidium oppositifolium*, is a herbaceous evergreen, of about a foot in height, carrying white flowers in June and July. It is a native of Syria, and is cultivated there as food for cattle, and was introduced about 20 years ago to Britain, but is as yet rather too tender for open-ground cultivation in our climate. The name eunomia signifies "good fodder."

EUONYMUS. See Spindle-Tree.

EUPATORIA. See Agrimony. Eupatoria is also the specific name of a handsome, pink-flowered, perennial-rooted, hardy stevia from Mexico.

EUPATORIUM. A large genus of plants, of very various form and habit, constituting the type of a prime division of the composite order. This division, the eupatoriæ, comprises twelve genera, the best known of which are ageratum and stevia. The genus eupatorium belongs to almost all parts of the world, and comprises deciduous herbs, evergreen herbs, herbaceous twiners, evergreen shrubs, and evergreen undershrubs. About 150 species of it are known to botanists, and one of these is indigenous in

Britain, while about 60 have been introduced from foreign countries to our ornamental and botanical gardens.—The indigenous species or hemp agrimony, *E. cannabinum*, is a rough perennial-rooted herb, and grows in watery, boggy places of both England and Scotland. Its root is somewhat creeping, and has numerous long fibres; its stems are downy, frequently brown or purplish, full of pith, branched, and from 2 to 5 feet high; its leaves are deep green, downy, and roughish, and stand on short footstalks; and its flowers have a pinkish or pale purplish colour, grow in dense, corymbose tufts at the ends of the stem and branches, and appear from July till October.—The fragrant species, *E. odoratum*, is an evergreen shrub of Jamaica, and was introduced to Britain about the middle of last century. It has usually a height of about a yard, and carries pink flowers throughout most of autumn.—About 30 of the hardy perennial-rooted herbaceous species are suitable for the parterre, and about 10 of the evergreen shrubby species for the greenhouse or the stove; and the majority of these have white flowers, while most of the others have either pink or purple flowers. —Eupatorium is also the specific name of a hardy, evergreen, herbaceous, ornamental, yellow-flowered milfoil, of about 4 feet in height, from the shores of the Caspian sea.

EUPHORBIA,—popularly *Spurge*. A large and important genus of plants, constituting the type of the natural order Euphorbiaceæ. This order is very extensive, and exceedingly varied. Nearly 500 species of it exist in the fields and gardens of Great Britain; and these are grouped into 6 suborders, and distributed into 47 genera. The types of the 6 suborders are the genera euphorbia, buxus, acalypha, phyllanthus, croton, and hippomane; and the most notable of the other genera are jatropha, janipha, sapium, dalechampia, mercurialis, ricinus, hura, omphalea, crozophora, excœcaria, plukenetia, cicca, and siphonia. The plants of the order belong to almost all parts of the world, and vary from tall and bulky trees to the most short-lived annuals, and from objects of commanding elegance to objects of grotesqueness and singularity. Some have both calyx and corolla in a condition of large and showy floweriness; others have no florification whatever except mere stamens and pistils; and all exhibit such varieties, discrepancies, and contrasts of botanical character among themselves, as to be classifiable only by the tricoccous form of their fruit, and a peculiarly characteristic and most virulent acridity in their juices. They are regarded by Jussieu as diclinous dicotyledons; and yet they possess very obvious affinities to the orders of at once the mallow, the staff-tree and the oleaster. They require, above most plants, to be readily distinguishable by gardeners, farmers, and general observers, on account of the strong acridity of the juice of all, and the dreadful noxiousness of the juice of many. Loudon, in his Hortus Britannicus, speaking principally on the authority of Jussieu's monograph of the order, says, "It is for their medicinal properties that they are chiefly known; and these are as various as their aspect,—mostly, however, dangerous, and always to be suspected. In a few of them, the smell and taste are aromatic; but in most there is either no smell or it is nauseous, and the taste constantly acrid and pungent. Some possess also an acrid limpid fluid, which is given out by the leaves when touched. Many of them act strongly upon the kidneys, as several species of phyllanthus, the leaves of Mercurialis annua, and the root of Ricinus communis. Many are said to be powerful medicines in cases of dropsy. The bark of several crotons, the wood of Croton Tiglium and buxus, the leaves of the same, and also of Cicca disticha, several euphorbias, and others, are recorded as sudorifics, and useful against syphilis. As emetics, we find the roots of the euphorbias, the juice of commia, anda, mercurialis perennis, &c. A great number are purgative, especially the leaves of buxus and mercurialis, the juice of euphorbia, commia, hura, the seeds of ricinus, croton tiglium, anda, and jatropha. The effects of some others are so dangerous, particularly hippomane, that it is not advisable to administer them even in very small doses. Even in many euphorbias, it is difficult to draw a line between the quantity in which they are poisonous, and that in which they are harmless or useful. The nature of their poison is mostly acrid, occasionally, however mixed with something narcotic, as is apparent from the effect of those which are used for poisoning or rather stupefying fish. The purgative oil in which the seeds of many are fonnd to abound, has been determined to reside wholly in the albumen; hence the embryo of some, as Omphalea diandra, is eaten as nuts. Boiling or roasting has also the effect of dissipating their noxious effects; thus Janipha manihot, than which there scarcely exists a more dangerous poison, affords a food when submitted to fire, called cassava, the flower of which is often used in London as a luxury for making puddings, than which few are reputed to be more wholesome. But the most curious of all the prodncts of Euphorbiaceæ is the caoutchouc, that singular substance which, although the produce of dangerous acrid trees, possesses nothing whatever which has been found capable of acting upon the human system in whatever way applied, which is unalterable either in air, in water, or in spirits, although it softens at a high temperature. Tournesole, another curious chemical preparation, is the juice of Croton tinctorium, but is also found in several others. Many other properties belong to this order, which it would be too long to detail in this place." Excœcaria takes its name from the tendency of its juice to produce blindness; and hippomane takes its name from its tendency to produce madness in the horse, and is so actively and dreadfully dangerous as to shed a noxious influence upon any person standing under its shade. About 120 or 125 of the species in Britain are hardy herbs, about a dozen are hardy ligneous plants, and all the others are tenants of the greenhouse or the hothouse.

Fourteen species of the genus euphorbia are indigenous in Britain; and upwards of 200 species have been introduced from foreign countries. The very genus exhibits the same extraordinary diversity as the order. One division of its species, inhabiting most parts of the world, and comprising all the kinds which grow wild in Britain, have involucres which were formerly mistaken for calyxes, and lift up these involucres from among large leafy bracts, and display a general leafiness and herbaceousness of appearance; and another division, inhabiting the hot parts of the world, and comprising nearly all the species cultivated in our greenhouses and hothouses, have a grotesque, leafless, evergreen, succulent, undershrubby character so similar to that of cacti as to be distinguishable, chiefly by an abundant discharge of their milky acrid juice when punctured, and partly by their either totally wanting spines, or possessing them singly and not in clusters.

The caper spurge, *E. lathyris*, is a biennial weed of dry stony places of cottage gardens in England. Its root is fibrous and strong; its stem is smooth, cylindrical, purplish, and hollow, and usually attains a height of about 3 feet; its leaves are opposite, in fours, sessile, oblong, acute, entire, and smooth; its flowers display some variegation of colour, and appear from May till October; its capsules are smooth and large; and its seeds yield by compression a powerfully and dangerously purgative oil, of kindred nature to the oil of Croton Tiglium.—The wild purslane spurge, *E. peplis*, is an annual weed of the sea-shores of England, about a foot in height, and flowering in July and August.—The small spurge, *E. exigua*, is an annual weed of British corn-fields, about 6 or 8 inches in height, and flowering in July. —The devil's milk spurge, *E. peplus*, is an annual weed of the cultivated lands of Britain, 9 or 10 inches high, and flowering in July and August. —The Irish species, *E. hibernica*, is a singular-looking, herbaceous evergreen of the fields of Britain, about a foot in height, and flowering in May and June.—The Portland spurge, *E. portlandica*, is a handsome-looking herbaceous evergreen of the sea-shores of Britain, 3 or 4 inches in height, and flowering from May till September.—The sun-noticing spurge or wartwort, *E. helioscopia*, is an annual weed of the corn-fields of Britain, 9 or 10 inches in height, and flowering in July and August.—The paralias spurge, *E. paralias*, is a curious yet handsome herbaceous evergreen, of the sea-shores of Britain, about a foot in height, and flowering from July till September.—The esula spurge, *E. esula*, is a singular-looking herbaceous evergreen of the woods of Britain, about 6 inches in height, and flowering from May till July.—The cypress spurge, *E. cyparissias*, is a handsome herbaceous evergreen of the woods of Britain, about 2 or 2½ feet in height, and flowering from May till September.—The broad-leaved spurge, *E. platyphyllus*, is an annual weed of the corn-fields of England, about a foot in height, and flowering in July and August.—The strict spurge, *E. stricta*, is an annual weed of the corn-fields of England, about 20 inches in height, and flowering in July and August.—The characias spurge, *E. characias*, is a small, handsome, evergreen shrub of the hills of England, about 4 feet in height, and flowering from March till June.—The almond-like species, *E. amygdaloides*, is a beautiful evergreen undershrub, of the woods of England, about two feet in height, and flowering from March till June.

The officinal spurge, *E. officinarum*, abounds in many parts of Africa, and was introduced to Britain toward the close of the 16th century. It is a succulent, evergreen, grotesque-looking shrub, requiring in this country the culture of the dry stove. The stem is simple, cylindrical, erect, furrowed or angled, with about a score of longitudinal fissures, and usually about 5 or 6 feet high. The branches grow out in all directions from its summit, first horizontally, and then ascendingly, so as to assume collectively the appearance of a huge vessel resting on a footstalk; and they are furrowed more sharply than the stem, scolloped, armed everywhere with pairs of prickles, and each about half an inch in diameter. Tubercles adjoin each pair of prickles, and serve the plant instead of leaves. The involucres, with the fructification, grow at the extremities of the branches, and are persistent, one-pieced, and four or five toothed. The capsule is tricoccous and elastic, and contains round solitary seeds.—The antique spurge, *E. antiquorum*, is a native of India, and was introduced thence to Britain some time after the middle of last century. It closely resembles the preceding species in character and habits, but usually obtains a height of about 9 feet.—The Canary spurge, *E. canariensis*, is a native of the Canary Islands, and was introduced thence to Britain toward the close of the 17th century. It also resembles the officinal spurge, but attains a height of about 20 feet, and flowers early in the year.—The gum EUPHORBIUM, noticed in next article, can be procured from not a few of the spurges, but is obtained for the uses of the druggist principally from the three exotic species now noticed.—Some of the very diversified and peculiar characters of the succulent, leafless, hothouse species, are sufficiently indicated in their respective designations,—the cereus-like, the cup-bearing, the pendulous, the globose, the procumbent, the cucumber-like, the squarrose, the nine-angled, the teated-angled or mammillarial, the large teated, the spreading, the tuberculated, the club, the spine-fruited, the many-angled, the wool-bearing, the melon-formed, the medusa-head, the hooked, the bracted, and the honey-bearing.—The ipecacuanha spurge, *E. ipecacuanha*, a hardy herbaceous evergreen of two feet in height, introduced about 35 years ago from North America, is said to have a root of precisely similar medicinal properties to those of the true ipecacuanha plant.—The ophthalmic spurge, *E. ophthalmica*, a very tender annual of an inch or two in height, introduced about 20 years ago from Rio de Janeiro, possesses some esteemed medicinal properties.—The scarlet-flowered spurge, *E. punicea*, an evergreen shrub of 6 or 7 feet in height, introduced in the latter part of last century from Jamaica, is an elegant plant, and by far the most ornamental of the spurges.

EUPHORBIUM. The gum or concreted juice of *Euphorbia officinarum* and other spurges. It is obtained from slight incisions made with a knife, and flows in the form of a milk-like juice; and it concretes by exposure to the air into small roundish or oblong pieces. Persons who gather it require to use all caution that none of the juice touch their skin to corrode it; and they need also to keep their mouth and nostrils covered with a cloth, to protect them from the inflaming dust of decayed portions of the plants. The gum has no smell; and, when brought into contact with the palate, seems at first to have little or no taste, but soon creates throughout all the mouth and the throat a sensation of burning, which is of long continuance and absolutely torturing. It was formerly administered as a hydragogue cathartic in cases of dropsy; but it acts with such tremendous violence that all considerate physicians have ceased to use it for internal exhibition. When greatly diluted with some inert powder, such as starch, it serves well as a rubefacient; and when still further diluted, it serves also as a valuable medicinal snuff, in deafness, palsy, lethargy, and similar cases; yet even then it must be used with caution, lest it should provoke copious bleeding from the nose, and swelling of the facial integuments. It has been much and infamously used in horse-blisters, and has killed some horses, and dreadfully tortured many; and it ought to be thoroughly unknown in veterinary practice.

EUPHORIA. A genus of tropical, evergreen fruit-trees, of the soap-berry tribe. Two species have been introduced to Britain from China, and two from Hindostan. All have a height of from 14 to 22 feet, and carry white flowers, and bloom in summer. The name euphoria signifies 'bearing-well,' and alludes to the profusion of the fruit.

EUPHRASIA. See EYEBRIGHT.

EUSTACHYS. A perennial, West-Indian grass, of the chloris tribe. It has been regarded by some botanists as a chloris, and by others as an agrostis; but it has characters which place it in the Linnæan class and order, *Polygamia monœcia*, and it really constitutes a genus of itself, with the specific name *petræa*. It has a dwarfish stem, and a large spike.

EUSTOMA. A genus of beautiful flowering plants, of the gentian family. The tall species, *E. exaltatum*, is a recently introduced greenhouse biennial, from Mexico, Vera Cruz, Cuba, Tampico, St. Domingo, and the Havannah. Its form is upright, branching, and somewhat naked; its leaves are opposite, sessile, elliptico-oblong, glaucous, and bluish; and its flowers are somewhat broadly bell-shaped, divided at the edge into five obtuse segments, and of a pretty lilac colour.—The silene-leaved species, *E. silenifolium*, is a hardy, white-flowered annual, of a foot in height, introduced about 40 years ago.

EUTERPE. A genus of beautiful, tropical trees, of the palm-tree family. Four species, all naturally attaining a height of about 35 feet, have been introduced to British palm-houses; and several other species have been scientifically described. This genus is akin to the arecas, and takes its name of euterpe or 'the pleasant,' from the fine appearance of its plants.

EUTOCA. A genus of ornamental herbaceous plants, of the water-leaf tribe. The earliest known in Britain was introduced in 1826; and already 8 or 9 hardy annual and biennial species figure in the yearly lists of the seedsmen. The many-flowered, Franklin's, and the linear-leaved, have pink flowers, the spreading, Mangles' and Menzies', have violet flowers, the clammy has dark blue flowers, and Wrangles' has purplish blue flowers; and Mangles' is very low-growing, Franklin's, Menzies', Wrangles', and the spreading, about a foot high, and the others about 20 inches high. All these, as to both habit and general appearance, have a close affinity to the nemophilas. The silky species, *E. sericea*, is a hardy, herbaceous, evergreen perennial, with blue flowers and about a foot in height, introduced in 1827 from North America.

EVAPORATION. The quiet and comparatively cool transition of water and other substances into a vapoury or aeriform condition. Ebullition or the formation of steam is strictly identical with it in principle, but differs in the tumultuous motion which attends it, in the high degree of heat which it requires, and in the rapidity, volume, and mechanical power of its evolution. Most, or probably all liquids are evaporable; and a few solids, such as camphor and the carbonate of ammonia, pass directly into the state of vapour. Evaporation takes place at all ordinary temperatures, from the lowest in our climate, up to the boiling point, but is greatly and progressively accelerated by increasing degrees of heat; and it proceeds with the most rapidity in substances which have the lowest boiling-point, and with the least in those which have the highest boiling-point,—more rapidly in ether than in alcohol, and more rapidly in alcohol than in water. Its occurrence at low temperatures is proved by the disappearance in the course of a few days of water exposed to the air in a shallow vessel in winter; and its accelerated evolution with increase of temperature is proved by the far earlier disappearance of a quantity of water in a saucer in a warm situation, than of the same quantity of water in a saucer of the same shape and size in a cold situation. Evaporation takes place only from the surface of substances; so that the rapidity of it relatively to the whole volume of the substance, depends on the extent of surface exposed to the air. Evaporation is far more rapid in a dry than in a moist atmosphere,—in even a dry cold day of winter than in a moist warm day of spring; and it is also much more rapid in a current of air than in still or nearly stagnant air,—the current carrying away the successive portions of air which become moistened with the rising vapour, and continually bringing fresh portions, which are drier and therefore more susceptive. Evaporation is greatly accelerated by decrease of atmospheric pressure, and proceeds so rapidly in the vacuum of an air-pump as to rouse ether into a state of ebullition. The cause of evaporation was long a problem to chemists, and the subject of some mistaken theories, but is now convincingly proved to be mere and simple action of heat. The quantity of water which it takes up exceedingly varies according to circumstances, and is noticed in the section 'Vapour of Water' of our article ATMOSPHERE. The effects of it upon the soil, upon vegetation, and upon animal health, are many and powerful, and may be very materially controlled by georgic operations, particularly by those of draining. See the articles ATMOSPHERE, DRAINING, COLD, and HEAT. In pharmacy, when any salt or other fixed substance, is sought to be obtained from a state of solution in water or any other very common or cheap liquid, evaporation of the liquid is effected in shallow, flat-bottomed vessels; and when the liquid is of a valuable kind, it is first driven off in the form of vapour, and then recovered by recondensing, in the process of distillation.

EVENING-FLOWER,—botanically *Hesperantha*. A genus of ornamental, bulbous-rooted, Cape-of-Good-Hope plants, of the iris tribe. Six species, all about 6 or 7 inches high, and five of them carrying violet-coloured flowers, are cultivated in some of the greenhouses of Britain. They are nearly allied to the ixias.

EVENING-PRIMROSE. See ŒNOTHERA.

EVERGREEN. A plant which retains its leaves throughout winter, and acquires a growth of new ones before fully shedding the old. Evergreen herbaceous plants comprise all herbaceous perennials which possess perennial stems; and evergreen trees and shrubs comprise, not only such as exhibit a full clothing of foliage at every season of the year, but such as suffer a partial and thinning fall of leaf in the end of autumn and the early part of winter, and such as, while fully clothed with verdure throughout the winter, are partially or wholly destitute of it throughout part of spring or summer. In the popular sense, however, evergreens are only such trees and shrubs as display perpetual verdure; and these—as well as, in a less degree, the ligneous subevergreens—have a harder cuticle, a thicker folial parenchyma, and a much smaller number of stomata, than deciduous plants. The leaves of the great majority have a leathery, glossy, darkish-coloured character, which is instantly detected by even a very moderately practised eye.

Hardy evergreens are in great and universal request for shrubberies, gardens, parks, embellished cemeteries, and all other kinds of ornamental grounds; and tender evergreens, of almost every conceivable variety of character, constitute a very large proportion of the tenants of all conservatories, plant-rooms, greenhouses, and garden-stoves. Among the most ornamental hardy climbers and twiners, are the common ivy, the Irish ivy, the greater periwinkle, the lesser periwinkle, the common jasmine, several of the honeysuckles, several of the clematises, and a number of the trumpet-flowers; among the most ornamental hardy shrubs, are the dwarf pines, the dwarf firs, the sweet bay, the Portugal laurel, the cherry laurel, the large varieties of the common box, the aucuba, the alaternus, the thoroughly evergreen variety of the common privet, a number of the junipers, the hollies, the phillyreas, the strawberry-tree, the andrachne, the bear's-grape, Irish heath, common rosemary, Spanish broom, common furze, mahonias, cotoneasters, andromedas, kalmias, lavender, cistuses, the common white broom, spurge laurel, several daphnes, garryas, dyer's broom, helianthemums, common myrtle, laurustinus, escallonias, yuccas, rhododendrons, and magnolia grandiflora; and among the most ornamental hardy trees, are the pines, the firs, the cedars, the auracarias, cunninghamia, the cypresses, the yews, the evergreen oaks, the arborvitæs, the strawberry-tree, the tree andromeda, the wax-tree, and several eucalypti. A tolerably full enumeration of tender evergreens would be an enormous catalogue.

American hardy evergreens, such as the rhododendrons and the kalmias, succeed best in a mixture of sand, peat earth, and vegetable mould; and most of the other hardy evergreens grow well in almost any kind of soil, but prefer a hazelly loam. The transplanting of them may be effected in any part of autumn, winter, or spring, or even in cloudy weather in the height of summer; but is most eminently successful in the end of autumn or the beginning of winter. "I have," says Mr. Macnab of the Edinburgh Botanic Garden, "planted evergreens at all seasons of the year with nearly equal success, except from the middle of June till the middle of August; and even during this period I have planted some; but unless the weather is very dull and moist, it is difficult to prevent the plants suffering considerably, and in many cases it is years before they recover. Although, however, I have planted evergreens ten months out of the twelve with little difference of success, yet one season has a preference over the others with me; and when there is the power of choice, I would recommend late in autumn, winter, or early in spring,—that is, any time from the middle of October till the middle of February; and in general, the beginning of this period is the best,—that is, from the middle of October till the middle of December; always providing that the weather and the ground are favourable,—that is, supposing that there is no frost, no drying wind, nor much sunshine, and that the ground is not too much saturated with wet, either from continued rain or from the nature of the soil. One of the principal things to be attended to in planting evergreens is to fix upon a dull day for winter planting, and a moist day for spring and autumn planting."

EVERLASTING. Any plant whose flowers retain their form and colour during a very long time after being gathered. The tissue of the flowers is so hard, and contains so exceedingly little moisture, as to be incapable of shrinking and withering in the manner of that of ordinary flowers. But the floral parts of most everlasting flowers are not showy petals or coloured calyxes, but chiefly bracts or the scales of involucres; so that they are apt to be pronounced by unscientific observers "no flowers at all." The principal hardy everlastings are most of the gnaphaliums, all the antennarias, all the xeranthemums, several of the helichrysums, and Mangles' rhodanthe; and the principal tender ones are all the ammobiums, most of the helichrysums, several of the gnaphaliums, all the astelmas, and several of the globe amaranths. All, except the amaranths, belong to the composite order; and all, except the amaranths and the rhodanthe, belong to the thistle division of that order. The amaranths and the rhodanthe are beautiful; the xeranthemums, some of the gnaphaliums, two of the astelmas, and most of the helichrysums, are highly ornamental; and the fine astelma, the hundred-flowered astelma, and the great-flowered, cinereous, woolly-stemmed, acuminate, small-leaved, spreading, curled, tree, herbaceous, and shining helichrysums, possess much elegance or are otherwise strongly attractive and pleasing.

EVERLASTING-PEA. Two indigenous, perennial-rooted, climbing, ornamental, herbaceous, leguminous plants, of the lathyrus genus. The broad-leaved everlasting-pea, *Lathyrus latifolius*, grows wild in the woods of some parts of England. Its root is comparatively large; its stem usually attains a height of about two yards; and its flowers have a pink colour, and bloom in July and September. It has been recommended for cultivation as a forage-plant. It is easily managed; and, though unproductive in the first year, it afterwards yields annually a great bulk of excellent provender.—The wood everlasting-pea, *Lathyrus sylvestris*, grows wild in the moist woods of both England and Scotland, has a height of about a yard, and carries purple flowers in July and September.

EVOLVULUS. A genus of ornamental, trailing, herbaceous plants, of the bindweed tribe. The flax-leaved species, *E. linifolius*, is a hardy annual of about two feet in height, carrying blue flowers in August and September; and Nuttall's species, *E. Nuttallianus*, is a hardy annual, of a few inches in height, carrying blue flowers from June till August. Ten or eleven species, principally blue-flowered, hothouse annuals, have been introduced from tropical America and the two Indies; and about as many more have been scientifically described. They do not twine like the true bindweeds, but roll out or roll along; and hence the name evolvulus.

EWE. The female of the sheep. See the articles SHEEP, ABORTION, and PARTURITION.

EWE-NECK. A malformation in the neck of some horses. A ewe-necked horse "has a neck like a ewe,—not arched above, and straight below, until near to the head, but hollowed above and projecting below,—and the neck rising low out of the chest, even lower sometimes than the points of the shoulders. There can scarcely be anything more unsightly in a horse. His head can never be got fairly down; and the bearing rein of harness must be to him a source of constant torture." [Youatt.]—A ewe-necked horse may be a good racer, but is necessarily a very bad hack.

EXACUM. A genus of ornamental, herbaceous plants, of the gentian family. Nine or ten species formerly belonging to it are now distributed among five other genera. The pretty species, *E. pulchellum*, is a hardy, pink-flowered annual, of 3 or 4 inches in height, introduced 20 years ago from North America; and the four-cornered species, *E. tetragonum*, is a hardy, blue-flowered annual, of about 20 inches in height, introduced 25 or 26 years ago from Nepaul. About a dozen other species are known to botanists. The name exacum signifies 'the expeller,' and alludes to a supposed power in the plants to expel or neutralize poison.

EXCÆCARIA. A genus of ornamental tropical plants, of the euphorbia family. Three species, all evergreen shrubs, of about two yards in height, and flowering throughout the greater part of the year, have been introduced to Britain from Chili and the two Indies; and 7 or 8 other species are known to botanists. The acrid juice of the plants causes blindness; and hence the name excæcaria. See the article EUPHORBIA.

EXCITABILITY OF PLANTS. The capacity or organic habit of being stimulated in seed, stem, leaf, and flower, by the external agencies of heat, moisture, and light. The excitability of the seed under the agency of heat is identified with a large proportion of the phenomena of germination. See the article GERMINATION. The stems of some of the mimosa family stand at various and widely different angles in successive parts of the day and night, according to the rise and fall of temperature; and the folioles of some of the papilionaceous legumes rise to a vertical position on each side of the leaf-stalk, when under the full play of hot summer sunshine.

The flowers of many plants, particularly of monopetalous weeds and of the ray-floreted kinds of compositæ, are so much affected by vicissitudes of humidity in the atmosphere as to be decided indicators of change of weather. When the Siberian sow-thistle shuts at night, the following day is fair, and when it opens at night, the following day is either cloudy or rainy; when the single African marigold rolls up its florets, at any advanced hour of the morning, or at any hour thence till the evening, rain very soon falls; and when the cornfield bindweed or the cornfield pimpernel closes its corolla, rain very soon falls.

The stem of a plant placed in an obscure room, with only one window or aperture for the admission of light, is drawn or bent toward the aperture; and the stem of any succulent plant, such as a hyacinth, placed with one side toward sunshine and the opposite side toward an obscure light, as at the window of a sitting-room, will bend over or bulge out on the sunshiny side. The stems of many plants, whether herbaceous or woody, growing in the open air in our climate, exhibit a greater profusion of branches or of general growth on the south side than on the north. The leaves of all plants, with exceedingly few exceptions, turn their upper surface to the direct play of light; and, when artificially twisted out of that direction, will either speedily resume it or perish. The flowers of multitudes of the most common or showy phænogamous plants, are open during the day or part of the day, and shut during the night; those of some are open only during clear or sunshiny weather, and shut during all dull and heavy weather; and those of a few are opened or shut by so precise an amount of light from the time of sunrise, or by so uniform a measure in the inclination of the angle at which it falls upon them, as to serve as natural dials or indicators of the hours at which they open and shut. According to the recorded observations of Linnæus, Tragopogon luteum opens at 3 in the morning and shuts at 9 in the morning, Crepis tectorum opens at 4 in the morning and shuts at 10 in the forenoon, Sonchus levis opens at 5 in the morning and shuts at 11 in the forenoon, Sonchus repens opens at 6 in the morning and shuts at noon, Lactuca sativa opens at 7 in the morning and shuts at 10 in the forenoon, Hieracium pilosella opens at 8 in the morning and shuts at 2 in the afternoon, Calendula arvensis opens at 9 in the morning and shuts at 3 in the afternoon, Mesembryanthemum neapolitanum opens at 10 in the forenoon and shuts at 3 in the afternoon, Ornithogalum umbellatum opens at 11 in the forenoon and shuts at 3 in the afternoon, the majority of Mesembryanthemums open at noon, Scilla pomeridiana opens at 3 in the afternoon, Silene noctiflora opens at 6 in the evening, Cereus grandiflorus opens at 7 or 8 in the evening, and Convolvulus purpureus opens at 9 or 10 at night.

EXCREMENT. The substances rejected and expelled by the alimentary system of organic beings. The excrement of man and all kinds of domestic animals is universally known to act with high manurial power upon the soil; and that of cultivated vegetables is believed to act in so peculiar a manner as to require a frequent or almost constant change of crops in order to the prevention of most mischievous effects. Both classes of excrement, therefore, require to be well understood by every intelligent cultivator. But vegetable excrement forms the topic of the article EXCRETION, animal excrement, in a collective view, is discussed in the article ANIMAL MANURES, liquid animal excrement forms the subject of the article URINE, two of the most powerful kinds of solid animal excrement in use are appropriated to the articles NIGHT-SOIL and GUANO, some of the most active compounds of animal excrement form the subjects of the articles POUDRETTE, GULLE, AHL, COMPOST, and FARM-YARD MANURE, and some of the most distinguishing properties and most valuable chemical forces of all animal excrements are noticed in the articles AMMONIA and AZOTE. Our only business in the present article, therefore, is to submit some statements, more or less descriptive and analytic, on the specific solid animal excrements which are usually available for the uses of the garden and the farm.

Night-soil is very variable in constitution, but always abounds in carbon, hydrogen, oxygen, and nitrogen, and contains some proportion of phosphates, sulphates, and earths. An analysis of it by Berzelius—but without any mention being made of the variety of it, or of the precise kinds of alimentary substances whence it was rejected—shows 733 parts in 1,000 of it to be water, 9 parts albumen, 9 bilious matter, 27 peculiar extractive matter, 140 mucus, bilious resin, fat, and peculiar animal matter, 12 phosphates of lime and magnesia, and carbonate, muriate, and sulphate of soda, and 70 vegetable fibre or course remains of vegetable aliment; and a supplement to the same analysis shows that 1,000 parts of it yield 150 parts of ashes, and that these 150 parts consist of 8 of carbonate of soda, 100 of phosphates of lime and magnesia, with traces of sulphate of lime, 8 of sulphate of soda, with a little sulphate of potash and phosphate of soda, 16 of silica, and 18 of charred or unburnt matter. But these elements greatly vary in their proportions, and some others very generally occur, in other varieties of night-soil; and all, in fact, are exceedingly controlled by health, by habits, and especially by food. Some small portions of alumina and of the oxides of iron and manganese, though undetected by Berzelius, are almost always present; silica may either be very abundant or very sparse according to the predominance of cereal or of animal food; and phosphates, sulphates, and nitrogenous compounds, in such quantity and form as to be capable of rapid, abundant, and most offensive decomposition, occur so uniformly and abundantly as to render this excrement disgustingly and most odiously distinguishable from that of all other animals. An ultimate analysis by Playfair shows three parts in four to be water, and ascertains 45·24 per cent. of the anhydrous part to be carbon, 6·88 hydrogen, 34·73 oxygen and nitrogen, and 13·15 ashes. Night-soil, notwithstanding its very large proportion of water, decomposes with far greater rapidity than the excrement of cattle; and when not very speedily used for manuring, or so treated as to have its chemical affinities greatly changed, it sends off the great bulk of its manurial elements in the gaseous forms of ammonia, carbonic acid, sulphuretted hydrogen, and phosphuretted hydrogen. Its manurial power is of the highest order, and ought always to be carefully retained and applied; and the full retention of this power at the same time prevents the evolution of those gases which constitute its vile and unhealthy malodour; so that a little care might everywhere combine enrichment of the land with purity of atmosphere. Its stench is a combination of ammonia, sulphuretted hydrogen, and phosphuretted hydrogen,—three substances which are somewhat fairly represented by sal volatile, rotten eggs, and putrid fish; and this is precisely a combination which even the slightest knowledge of agricultural and vegetable chemistry sees to be of prime value to the cereal crops of land which has been long in cultivation; and it is also one which, in various ways, and with the utmost ease, can be withheld from assuming its gaseous, offensive, and wasteful form, and delivered into the land with little less solidity and with far more inoffensiveness than bone-bust. "The best plan," says Dr. Sprengel, "is to cover and mix it at once with earth abounding in humus, with which a little marl may be mixed, and so leave it to ferment. All the ammonia is thus united with the humic acid as soon as formed. This process frees it from the odour which is so great an obstacle to its employment; and when the heap has been several times stirred over, it is easily spread." "The disagreeable smell of it," says Sir Humphrey Davy, "may be destroyed by mixing it with quicklime; and if exposed to the atmosphere in thin layers strewed over with quicklime in fine weather, it speedily dries, is easily pulverized, and in this state may be used in the same manner as rape-cake, and delivered into the furrow with the seed. The Chinese, who have more practical knowledge of the use and application of manures than any other people existing, mix their night-soil with one-third of its weight of a fat marl, make it into cakes, and dry it by exposure to the sun. These cakes, we are informed by the French missionaries, have no disagreeable smell, and form a common article of commerce of the empire."

The excrement of fowls combines the properties of both dung and urine, contains richly concentrated remains of nitrogenous and phosphuretted elements, and ranks next to night-soil in manurial power and value upon arable lands which have been severely cropped or long in cultivation. GUANO, consisting principally of the excrement of the gull or cormorant, is now well appreciated, and in vast request, for its great power; but the excrement of pigeons, hens, geese, ducks, and other domestic fowls, is scarcely if at all inferior, and might, to a very great extent, be made available as a common fertilizer. "Poultry-dung," says Dr. Sprengel, "is one of the most powerful manures, and is therefore worthy of greater consideration than is generally bestowed upon its collection, especially as it soon decomposes, and consequently loses so much ammonia; and it would lose a still greater quantity of that gas did the excrements not dry quickly, and thus prevent a further decomposition of their urea. The strongest are those of pigeons and domestic fowls,—a fact easily explained, by the circumstance of their living chiefly upon grain, insects, and worms; while geese eat grass also. That we may lose none of the ammonia developed during the putrefaction of poultry dung, we should do well to strew the yard and house in which they are kept with soil abundant in humus, for then the ammonia of the manure will be combined with the humic acid of the earth. The strewing of the ground with sand, sawdust, &c., as commonly practised, is, in this point of view, of no use whatever. The excrements of pigeons have been chemically examined by Sir Humphrey Davy and myself. Davy found in 100 parts, by weight, 23 parts of substances soluble in water, consisting of urea, urate of ammonia, common salt, and some others. According to my own experiments, pigeon dung, half a year old, contained only 16 per cent. of bodies soluble in water, consisting of very little urea, but of a large proportion of carbonate, sulphate, and humate of ammonia, common salt, and sulphate of potash; the other 84 parts insoluble in water, consisting of coarse silicious sand, silica, phosphates of lime and magnesia, traces of alumina, and oxides of manganese and iron. The abundance of soluble substances explains the quick effect of pigeon dung, and also shows us the great value of mineral manure. When the droppings of geese come in contact with the grass in pastures, they destroy it in a short time, so that farmers do not readily allow geese to have access to pastures; not to mention that, when the herbage is rendered foul by the excrements of these poultry, it becomes loathsome to other animals. The speedy injury inflicted on plants by goose-dung, is occasioned partly by the uric acid it contains, and partly by the ammonia which is so soon generated and developed on decomposition. When rain happens to fall, these caustic substances are diluted, and the grass grows the best in the places where the excrements lie, as may be seen in any goose-pasture. As poultry dung is very rich in powerfully manuring matters easily soluble in water, it should be applied only in very small quantities; and, in order to effect its due distribution, as it is generally dried strongly together, it must first be reduced into a fine state by thrashing or other means. In Belgium, they employ it particularly for manuring their flax, and calculate the annual value of the dung of 400 or 500 head of pigeons at 25 or 30 rix-dollars (about £5 or £6). Poultry dung must always be used as a top-dressing, or only harrowed in very lightly; and it should be spread over the ground when there is no wind. We should generally choose damp, but not wet weather, for the purpose, otherwise the main soluble substances would be carried too deep into the soil, or washed away altogether. If a meadow be manured with poultry dung, and sheep driven on it soon afterwards, it is almost entirely eaten bare by them, probably on account of the many salts, including common salt, contained in this manure. Like all other manures containing much ammonia, it soon destroys moss in meadows. When it is wished not to employ poultry dung by itself, it will be found best to mix it into a compost heap with some soil rich in humus. A soil of this kind should be used with all organic remains containing much nitrogen, as all loss is thereby prevented." The soil of such woods as are frequented by large flocks of wood-pigeons is highly impregnated with their dung; it has been found, upon analysis, to contain a very appreciable quantity of ammonia; it consists, to a considerable amount, of the humus of decayed leaves, nitrogenized by combination with the elements of the pigeon's dung; and it would, beyond question, prove a good manure for the ordinary fields of a farm. "The dung of fowls," remarks Sir Humphrey Davy, "is employed, in common with that of pigeons, by tanners, to bring on a slight degree of putrefaction in skins that are to be used for making soft leather. For this purpose, the dung is diffused through the water. In this state, it rapidly undergoes putrefaction, and brings on a similar change in the skin. The excrements of dogs are employed by the tanner with similar effects. In all cases, the contents of the grainer, as the pit is called in which soft skins are prepared by dung, must form a very useful manure."

The excrement of horses somewhat varies with their food, yet much less so than night-soil; and, in a general view, it is comparatively rich in nitrogen, rapid in decomposition, and powerful in manurial operation. In consequence jointly of its high nitrogenousness and of its greater solidity or anhydrousness, it evolves a higher degree of heat and throws off larger volumes of ammoniacal gas than any of the other kinds of animal excrement. An analysis of it by Zierl—in a case in which the horses had been fed on hay, oats, and straw—shows 698 parts of it in 1,000 to be water, 20 parts picromel and soluble salts, 17 bilious and extractive matter, 63 green humus matter, with intestinal mucus and coagulated albumen, and 202 vegetable fibre and remains of food; and a supplement to the same analysis shows that, upon the incineration of 1,000 parts, 60 parts of saline and earthy substances are obtained, consisting of 5 of carbonate, muriate, and sulphate of soda, 9 of carbonate and phosphate of lime, and 46 of silica. But alumina, magnesia, manganese, and iron, though overlooked by Zierl, and though sometimes in so small a quantity as scarcely to be appreciable in a meagre specimen, may be regarded as always present. When the fresh excrement is laid up in heaps, it heats, steams, ferments, rapidly decomposes, and gives off large quantities of ammonia, carbonic acid, and carburetted hydrogen; when it acquires great heat, it gives off carbonic oxide, passes into a half-carbonized state, becomes mouldy, and suffers enormous loss of its manurial power; and when it is amassed with unequal compactness, some portions being freely permeable by the air, and other portions almost impenetrable, it suffers unequal decomposition, and assumes a mixed and fitful character eminently detrimental to uniformity of crop on the land to which it is applied. In a regular and moderately fermented state, it possesses similar properties to the best varieties of "muck" or farm-yard compost; in a pasty state, with retention of its moisture during begun decomposition, it constitutes "spit dung," exerts both great and speedy manurial force, evolves heat within the soil to which it is applied, and is admirably adapted to lands of cold clay or to lands which contain a maximum of vegetable mould; and in a thoroughly reduced and pulverulent state, it constitutes "rotten dung," is greatly diminished in bulk, possesses higher but far less durable power than in either of the two preceding conditions, and exerts a mightily stimulating force upon vegetation, but, in consequence of the combined vigour and transiency of its action, is very ill adapted to any description of light soil. Dr. Sprengel recommends that horse-dung be always thrown into the farm-yard pit to constitute an ingredient in farm-yard compost; and adds, "If we manure a field with fresh horse-dung, and sow it immediately afterwards with corn, it frequently happens that the plants turn black and appear charred. This always arises from that portion of the ammonia, produced from the dung, which has not been neutralized by humic acid. This blackening of plants is erroneously regarded as the effect of smut. It is most likely to happen when a soil very deficient in humus has been manured with horse-dung. In order, therefore, that none of the ammonia may be lost in the form of gas, it will always be found the most advisable to apply fresh horse-manure where the soil is richest in humus; for so the manure has an useful effect on the component parts of the soil in rendering the humid acid more soluble. Horse-dung has the same effect as that of sheep when applied to cereal crops, producing an undue proportion of straw and thick-skinned glutinous grain."

The excrement of cattle widely varies according to health, condition, exercise, and food. That of a cow giving milk is considerably feebler in manurial power than that of barren or farrow cows; and that of either cows or oxen is different when depastured, and when stall-fed,—when foddered on straw, and when foddered on green clover,—when fed on potatoes, and when fed on mangel-wurzel. The dung of cows which had been fed on spurry was found by analysis of Einhof to consist of 71·7 per cent. of water, 9·3 of substances constituting a green mucus, and insoluble in water, 2·3 of substances soluble in water, and consisting of bitter matter, with potash and phosphate of lime, 15·6 of vegetable fibre, and 1·1 of sand, evidently referable to the spurry. The dung of cows which had been fed on dry food was found by analysis of Morin to consist of 70·0 per cent. of water, 24·1 of vegetable fibre, 1·5 of a green fatty substance and resin, apparently the half-decomposed green matter of leaves, 0·6 of a yellowish sweetish substance, probably picromel, 1·6 of a seemingly nitrogenous substance called by Morin bubulin, brown, shining, soluble in water, almost tasteless, and without any particular smell, 0·4 of coagulated albumen, and 1·8 of a brown resinous substance, apparently bilious resin. The dung of cows which had been fed on green food was found by the same analyst to consist of 71·2 per cent. of water, 22·8 of vegetable fibre, 1·6 of the green fatty substance, 0·6 of picromel, 1·9 of bubulin, 1·9 of coagulated albumen, and 1·2 of bilious resin. The dung of cows which had been fed on potatoes, beans, straw, and hay, was found by analysis of Zierl to consist of 75·4 per cent. of water, 1·1 of sugar of gall and some soluble salts, 1·1 of bilious and extractive matter, 8·3 of deposited humus, or more probably starch, with coagulated mucus and albumen, and 14·1 of vegetable fibre and the remains of food. Zierl found also that the dung which he analyzed yielded 6 per cent. of ashes, and that these consisted of 4·4 of silica, 1·2 of carbonate and phosphate of lime, 0·2 of carbonate, sulphate, and muriate of soda, and 0·2 of unascertained matter, which may be conjectured to have been magnesia, alumina, iron, manganese, and potash. In consequence of cattle-dung containing exceedingly little nitrogenous matter, it does not evolve during putrefaction any perceptible quantity of ammonia; and in consequence unitedly of its poverty in nitrogen, its abundance of water, and the coarsely divided condition of its vegetable remains, it is slow in decomposition, evolves very little heat by fermentation, passes under exposure to the air first into an unctuous paste and next into a consistence similar to dried peat or turf, and, when buried at any considerable depth in the soil, is almost totally inert and remains a very long time unaffected by change. It possesses in itself exceedingly little adaptation to manurial purposes; but it becomes valuable when mixed with both the urine and the litter of the cow-house and the cattle-shed; and it does best when thrown at every cleaning into the farm-yard manure pit so as to be a regularly intermixed ingredient of farm-yard manure. Yet whenever it is applied either by itself or as a predominating or even bulky ingredient of farm-yard manure, it ought never to be laid upon clay lands, but wholly distributed upon the sharpest and hottest, or upon the most sandy or gravelly, which exist within the limits of the farm.

The excrement of sheep, according to analysis by Zierl, consists of 67·9 per cent. of water, 3·4 of sugar of gall and soluble salts, 1·9 of bilious and extractive matter, 12·8 of humus, with coagulated albumen and intestinal mucus, and 14·0 of woody fibre and vegetable remains; and, according to a supplement to this analysis, it yields 9·6 per cent. of ashes, consisting of 6·0 of silica, 1·6 of carbonate, sulphate, and muriate of soda, and 2·0 of carbonate and phosphate of lime. But also traces of magnesia, potash, alumina, oxide of iron, and oxide of manganese, would no doubt be detected by a more searching analysis. When moist, and especially when amassed into a heap, sheep-dung rapidly decomposes, evolves a large quantity of ammonia, and suffers speedy dissipation; but when dried and so dispersed as to be kept from remoistening and heating, it decomposes slowly and imperfectly, and parts somewhat reluctantly with its remaining nitrogen. When spread fresh upon the land, or when dropped combinedly with urine in folding or pasturing, it acts with the same kind of rapid, powerful, and transient ammoniacal force as the excrement of horses, and possesses great adaptation to either good or evil according to the circumstances in which it is applied. "From the great quantity of ammonia which sheep-dung develops," says Dr. Sprengel, "may be explained its remarkable effect on every kind of soil containing a very large proportion of humic acid or carbonized humus, since it thus partly neutralizes the humic acid by the ammonia it gives out, and partly brings the carbonized humus by the same volatile alkali to speedy decomposition, or otherwise converts this useless substance into food for plants. The ammonia, however, is also the cause of the crops, especially of the cereal ones, being very liable to grow too luxuriantly after the application of sheep-manure, of the grain being very abundant in gluten, and of its not being suitable on that account for seed, the manufacture of starch, or even the distillation of brandy, although it is at the same time very nourishing. On soils which contain little humus, sheep-excrements, on the contrary, very easily injure the crops, from the ammonia which they develop burning them up, as we know by experience. Of this last fact we may easily convince ourselves, by watering plants with a concentrated solution of ammonia, even of the carbonate, as they become black, and appear as if charred; no heat, however, being produced, which could have occasioned such an effect."

The excrement of swine is far less analytically known than that of the other domestic animals; and is esteemed by some superficial thinkers the very best of manures, and by others the very worst. Swine are the most indiscriminate feeders of all the animals of the farm, and have also the strongest and most reductive powers of digestion; and hence their dung must both be exceedingly various in composition, and aggregately far less manurial than that of animals of less energy of stomach. The excrement of all ordinarily fed swine, no matter what be their habits or their particular food, is certainly poor in nitrogen, and slow in decomposition,—so that it becomes a fit manure for any good arable land only when combined with the excrement of horses or of sheep, or when otherwise worked into compostal conditions which shall correct its coldness, its resistance of decomposing forces, and its excessive poverty in nitrogen; and only the excrement of fattening swine,—or of such as have both a fat carcase and a highly nutritious diet,—possesses adaptations of itself to the manurial purposes of ordinary husbandry. One of the best methods of deriving manurial advantages from swine is to let the animals riot at will among an abundance of straw in the farm-yard, in order that they may both abrade the straw by mechanical action and work the debris of it and all their own excrements into such a mixture as shall fitly combine with the general compost of the pit of farm-yard manure. "The solid as well as the fluid excrements of the pig," remarks Sprengel, "must contain some substance which is very difficult of decomposition, and which is also soluble in water; for most esculent roots, when manured with pig-dung, acquire a very disagreeable flavour; and tobacco so grown is intolerable to the smell. They are best adapted for hemp; and some say, also for the hop-plant." —*Translation of Part of Professor Sprengel's Treatise on Manures.—Journal of Royal Agricultural Society of England.—Davy's Agricultural Chemistry by Shier.—Knowledge Society's Treatise on British Husbandry.—Liebig's Chemistry of Agriculture.—The Farmer's Magazine.—Marshall's County Reports.—Youatt on Cattle.*

EXCRETION OF PLANTS. The expulsion by living plants of substances or proximate elements unsuited for their assimilation or rejected by their secretive system. Chemical transformations of the proximate elements of a plant, or of the compound substances which exist within it, take place at all periods of its life, and are peculiarly numerous and important during the interval between the commencement of its flower-buds and the maturation of its seed; and these transformations, not only modify and change the component parts of its juices and secretions, but cause it to throw off constant successions of matter unfit for its use. A large amount of the ejected matter passes off in a gaseous form from the blossoms, from the young shoots, and especially from the leaves; a considerable amount, in the case of all ligneous exogens, is lodged in a dead condition on the exterior of the living cortical layers of the bark; an amount, varying from large to small according to the nature and the age of the plant, takes the form, within the soil, of either a dead exterior sheathing of the radical bark or of choked, decayed, and rejected radical fibres; and an unascertained and debateable but very important amount passes out in a liquid and perhaps also in a gaseous form, into the soil, through radical orifices similar to the spongioles, but with an expelling instead of an absorbing power. The excretion through the blossoms and the leaves is admitted by all phytologists, and is known to be a chief contrivance of the beneficent Creator for maintaining the atmosphere in a vital and salubrious condition for the use of animals, but exerts no immediate or direct influence upon the soil. See the articles ABSORPTION, ANALOGY, ATMOSPHERE, CAMBIUM, ELECTRICITY, and LEAF. The excretion through the cortical layers, in the form of dead outer bark, is also admitted by all who have adverted to it, and is believed to be the main cause, or at least the medium, of the many strong and peculiar principles, such as astringent, bitter, and tinctorial extractives, for which the bark of many trees and shrubs is remarkable. See the article BARK. The excretion of solid matter, whether cortically or fibrously through the roots, is to the full as obvious as the excretion through the cortical layers,—and may perhaps be found to abound in the fibrous form in herbaceous plants quite as bulkily as in the cortical form in ligneous plants; yet it seems to have been seldom adverted to in phytological inquiries; and it is very generally and not a little strangely overlooked in recent and existing conflicts of opinion respecting the influence which vegetable excretion exerts upon soil. The excretion of liquid matter through terminal orifices of the rootlets is a fact of recent discovery, confidently asserted by some of our most distinguished experimental phytologists, but denied, doubted, or very hesitatingly admitted by multitudes of both theoretical and practical cultivators, and often or almost always constituting the sole question at issue in a controversy which has for a number of years past been maintained respecting vegetable excrementation in the soil, and the necessity occasioned by it for a constant change or rotation of crops.

De Candolle teaches that after the sap of a plant has ascended to its upper extremities and undergone elaboration in the leaves, and after the cambium has descended to its lower extremities, and furnished to the various organs all the nourishment which it contains, a residue of particles incapable of assimilation with the plant exists in the form of liquid refuse,—that this residue is expelled into the earth through some of the orifices of the roots, in the manner of an excrement,—and that just as animal excrement cannot become food but might be positively deleterious to the particular system which has rejected it, so vegetable excrementitious deposit can never be nutritive but may be highly injurious to a future crop of plants of the same species as those which have expelled it. Some of the many distinguished phytologists who have adopted De Candolle's theory, have both slightly added to it and abundantly illustrated it by appeal to observation and experiment; and M. Macaire, one of the earliest of these, says, "It may also follow that the active virus of the organs of a vegetable converts the mixed particles into substances deleterious to the plant which produces it, or to others, and that a portion of this poison is also rejected by the roots. Some of my experiments have shown that, in fact, vegetables may suffer from the absorption of the poisons which they themselves furnish. The continual elongation of the roots prevents the effect from being hurtful to the same generation of plants; so that it is the next generation or following crop of them which suffers. It is possible to imagine, too, that on the contrary, these same excrements may furnish wholesome and abundant nourishment to another order of plants." De Candolle records, too, that he was indebted both for the elements of his theory, and for the earliest observations in illustration of it to some preceding philosophers. "M. Brugmans," says he, "having placed some plants in dry sand, saw some small drops of water exude from the extremity of the radicles. * * In fine, the roots themselves in some plants present particular secretions. This may be observed in *Carduus arvensis*, *Inula Helenium*, *Scabiosa arvensis*, several euphorbias, and several of the succories. It appears that these secretions of the roots are only parts of the juices, which not having served for nourishment, are rejected when they arrive at the inferior parts of the vessels. Perhaps this phenomenon, which is not easily perceived, is common to a great number of plants. M. Plenck and M. Humboldt conceived the ingenious idea of seeking from this fact the cause of certain habits of plants. Thus, we know that the thistle is injurious to oats, the euphorbia and scabiosa to flax, the *Inula betulina* to the carrot, the *Erigeron acre* and tares to wheat, &c. Perhaps the roots of these plants give out a matter which is hurtful to the vegetation of others. On the contary, if the *Lythrum salicaria* grows freely near the willow, and the branching orobanche near the hemp, is it not because the secretions from the roots of these plants are beneficial to the vegetation of the others?"

M. Macaire, in prosecution of De Candolle's theory, conducted an extensive series of select and instructive experiments. He selected as many plants of different natural orders as could be pronounced a fair specimen of the whole of the phænogams; he thoroughly washed their roots, and placed each in a certain quantity of pure water in a phial; and, after they had exfoliated, bloomed, and flourished, he ascertained, by evaporation and the use of chemical reagents, what matter had been exuded by their roots into the water. Some of the inferences which he deduced were, that most phænogamous plants radically excrete substances which are unfit for their own vegetation; that these substances vary in nature according to the natural orders to which the particular plants belong; and that some are acrid and resinous, and may injure other plants besides those which produce them, while others are mild and gummy, and may prove nourishing to other plants.—Water in which beans were grown became yellow, abounded in excrementitious matter of a gummy nature, and contained a little carbonate of lime. Another or fresh set of bean-plants did not live well in it; but wheat-plants relished it, rendered it less yellow, and evidently absorbed in a nutrient manner a portion of its excrementitious mixture. The cropping of wheat after beans would thus appear to be a good practice.—Water in which wheat, barley, and rye were grown, afforded them bad support, in consequence both of its want of ammonia and especially of its want of materials for forming the silicious epidermis of the culms; it was clear, colourless, odourless, and tasteless; it contained some alkaline and earthy muriates and carbonates, and only a very small proportion of gummy matter; and it was rendered additionally unfit, by its poverty in gummy matter, for the support of another set of cereal plants. An alternation of green crops and grain crops, with the view of making the former act as preparation for the latter, would thus appear to serve the important purpose of keeping up within the soil a requisite supply of gummy matter.—Water in which potatoes were grown afforded them good support, and enabled them to make a fair expansion of their leaves; but it was scarcely coloured, had little taste, left little residuum, and seemed to show that potatoes make very little decided excretion. The cultivation of potatoes in preparation for wheat, in as far at least as their excrementitious deposit is concerned, would thus appear to be bad agricultural practice,—or at any rate to derive such advantages as it possesses rather from the manuring and cleansing of the potato crop than from that crop itself.

The embrowning or blackening of yellowish or reddish virgin soil by cultivation is a fact familiarly known to all cultivators; and this fact, though ascribed by some writers wholly to the transmutation of the red oxide of iron into the black oxide, and by others partially to the formation of humus or decomposition of organic vegetable remains, may probably arise, in no inconsiderable degree, from vegetable excrementition. "Is this change of tint," says Mr. Towers, "effected by carbonaceous matter excreted from the roots by the decomposition of carbonic acid derived from the air, or by the partial deoxidation of the ferruginous constituent of the earth? The latter may probably operate to a certain extent; but I hold it more philosophical to conclude that the change in colour is to be ascribed to hydrogen gas (holding, perhaps, carbon and other matters in solution), emitted from the roots into the soil, and therein effecting chemical decompositions by specific elective or rather electric attractions. * * My experience has taught me this fact,"—the fact of great deepening of the colour of the soil in a garden-pot, by a single season's growth in it of a vigorous strawberry-plant; "and I ascribe the effect to the matter emitted by the roots into the earth. Earth so coloured is not, I conceive, exhausted. It is doubtless changed, and in time would be incapable of supporting the vegetation of the plant which had deposited the colouring matter within it; but in respect of mere abstract quality, it is unquestionably richer than it primarily was, having received more than it gave out, and is, in fact, manure for another species of vegetable."

Yet sound as Mr. Towers' general principle may be, he, in another paper, pushes it up to an extreme which appears to us both absurd and very mischievous. He there starts off from the broad fact that plants in the aggregate or in natural succession can never exhaust a soil, and rushes up to the narrow conclusion, "that weeds, poor despised weeds, unsightly as they appear, are not only harbingers of plenty, and prove the goodness of the soil they so speedily and unaccountably cover, but add riches to it, and a fund of nutriment for other and more refined crops." "Let us turn our eyes," he exclaims, "to the scarcely half-weeded garden of the cottager, and compare the enormous crops of bulky cabbages, healthy sound potatoes, onions, &c., with the comparatively poor and dwindled produce of a more wealthy neighbour, whose garden is seldom permitted to be disgraced by the presence of an unsightly weed!" He immediately admits, indeed, that "native weeds may overpower a crop, and deprive it of solar, electrical, and aerial influences;" yet he inculcates, as the practical application of his whole doctrine respecting weeds, that "all we have to do is to watch their progress in the garden and the field, and never suffer them to become masters." Now any cottage gardens which are really better than neighbouring aristocratic gardens, may easily be proved to owe their superiority to very different causes than the free growth of weeds; and the particular species of weeds which love the same kinds of nourishment, and make the same kinds of excretions, as cultivated crops are no doubt precisely those which flourish most under the same conditions of soil as these crops,—the gum-excreting weeds, for example, flourishing best with such a crop as beans, and the saline-secreting plants flourishing best with such a crop as wheat; and the artificial selection of one set of plants, and exclusion of all other sets, in the process of cultivation, necessarily disturbs and even reverses the order of continual and progressive enrichment which obtains in strictly natural vegetation; and some of the worst weeds which infest either field or garden will not submit to be "watched" so as to be kept from "becoming masters," but will be either master or nobody, either all luxuriance or nothing whatever. A corollary of Mr. Towers' general doctrine of excretion quite as obvious as his own, and scarcely a jot more absurd, is that a profuse artificial sowing of groundsel, thistles, dandelion, or colt's-foot, would make a capital preparation for wheat!

Both the fact and the diversified character of vegetable excretion are strongly evinced by the odours which soils acquire from the growth of different kinds of plants. So powerful is the aroma imparted to soil by some kinds of vegetables, that a spade cannot be put into a plot of ground on which they have recently grown, without liberating a volume of odour, sufficiently great to be discerned at the height of a foot or more above the surface. Cabbages, borecoles, broccoli, and almost all the other brassicas, impregnate the soil with an odour so marked and peculiar as to be readily recognised by every cultivator. Pease, when raised in pots or boxes for transplantation, fill the soil with their matted roots, and so thoroughly saturate it with their radical odour, that, on their being removed, it emits a powerful, peculiar, and readily recognisable smell. Kidney-beans produce a similar effect, but with a different kind of odour from pease; and most other genera of the large and important order of leguminous plants leave traces of themselves in the soil equally distinct and peculiar. In the repotting of house and conservatory plants, even in cases in which no odour is discernible from the mere stirring of the soil, a great variety of distinct and even powerful smells are evolved. The soil of coffee-plants, in the act of repotting, yields an odour akin to that in which our common leguminous plants have grown; that of heliotropes yields a powerful and almost animal scent; that of justicias yields a stale and fetid vegetable odour; that of some tropæolums yields a smell as pungent as if a quantity of bruised water-cresses were held close to the nose; and that of many other well-known plants yields effluvia quite as obvious and characteristic. Now whether these smells arise from exuded moisture or from decayed and comminuted radical bark or fibrous radicles, they are manifestly the direct product of excretion; for, according to the analogy of the essential oils, which may be regarded as the seat and the concentration of vegetable odours, they must consist, either wholly or almost wholly, of such variable compounds of carbon and hydrogen as are thrown out from the general system of assimilation.

Both De Candolle and Macaire, in treating of the excretion of plants as a cause of wearing out the soil by any one crop, and of rendering a succession or rotation of crops essential to maintained fertility, assigned to it far too high a power; and many of their followers have assigned to it all power whatever, or regarded it as the only cause of exhaustion. But in all ordinary cases, crops, when continuously grown upon one piece of ground, dwindle away and become poor and dwarfed, far less in consequence of the malign effect upon them of their own excrementitious deposits, than in consequence of their carrying away nearly the whole stock of some one or more elements of the soil which are essential to their healthy existence and vigorous development. If any entire crop were left undisturbed to decay where it grows, and to blend the whole of its substance again with the soil, it might be cultivated on the same piece of land throughout a very long course of years, before suffering any very serious detriment to its luxuriance; and if it were growing in a self-sown or thoroughly natural condition, it might have most of the deleterious effects of its own excrementitious deposits neutralized and perfectly corrected by those of self-sown and intermingled weeds. Hence the vastly long course of the same kinds of vegetation in prairies and forests, and the exceedingly remote intervals at which grasses and trees in a completely wild state undergo change or rotation. Soils, too, which are surpassingly rich in the precise mineral principles which are most required by particular cultivated crops, have been known to produce a constant and luxurious succession of these crops through so long a course of years as to have won for themselves the designation of perpetual soils; and even if lands which have for centuries been in cultivation, could, by virtue of minute chemical analysis on the part of the farmer, be supplied in the form of manure with precisely the needful elements in which they have become impoverished, they would unquestionably maintain their fertility with a vastly less frequent and fitful play of rotation than, in the present state of things, is found necessary. See the articles Agricultural Chemistry, Ammonia, Alkalies, Azote, and Rotation. Radical excretion, then, ought never to be mentioned as the chief cause, or as more than a very subordinate cause, of the necessity of rotations. But, on the other hand, the thoughtless and headlong error should be avoided, of rushing from such facts as we have now admitted into a denial of radical excretion altogether. How unphilosophical and misleading, for example, is such a passage as the following from Judge Buel of America: "In the great secondary formation of West New York there are hundreds, and, I believe, thousands of instances, where a wheat crop has been taken from the same field, ten, fifteen, and twenty years in succession, and in one instance at least twenty-two years, without any manifest diminution of product. Upon some of the alluvial flats of the Genessee Sciota, and other western rivers, Indian corn has been grown twenty or thirty years in succession, and before their settlement by the whites, it was grown time out of mind, it is believed, by the natives. These facts are wholly irreconcilable with the proposition of M. Macaire,"—the doctrine of the excretion of plants.

A series of experiments conducted by Alfred Gyde, Esq. of Painswick in Gloucestershire, and reported in a Prize Essay in the Transactions of the Highland Society, brings out very similar results to those of Macaire respecting the radical excretions of some of the chief agricultural plants, but affords little or no countenance to the opinion that these secretions are injurious to the vegetation of the species which eject them. Plants in bloom were found to yield the greatest quantity of excretion; and plants when maturing their seed, to yield little or none. Plants, such as the pea, the bean, and the kidney-bean, which have roots of a spongy texture, yielded much more than plants, such as wheat and barley, which have radical fibres of a firmer or more woody texture. The bean and the cabbage imparted to the water the strongest odour; and wheat and barley imparted no odour whatever. The water in which beans, kidney-beans, wheat, and cauliflower had been placed, and which had become impregnated with the excretion, was applied in the way of periodical watering to the roots of growing plants of the same species, and appeared either to produce no observable effect, or actually to confer a slight degree of benefit. The general conclusions drawn by Mr. Gyde from the whole course of experiments were, that most plants impart to water certain soluble substances or excretions,—that this is identical with the sap of the plant,—that plants have no power of selection, but take into their texture any solution offered to their roots, and have little or no power of again excreting it,—and that plants watered with excretion received no injury from it.

But these experiments and conclusions show such evident marks of defect and error, that they ought not for a moment to induce cultivators to neglect the requisite practices and calculations for controlling the effects of vegetable excretion. The identity of the excretions of plants with their sap, for example, is a downright absurdity. The sap ascends to the extremities, and is elaborated in the leaves, and there ceases to be sap; and even the cambium or descending juice—which Mr. Gyde possibly meant by the sap—assumes one chemical character in the leaves, another in the flower or the fruit, another in the bark or epidermis, another in the alburnum or in the substance of the culm, another in the body of the roots, another in the radical bark or in the fibrous rootlets, and, of course, another in deposition exteriorly to the root or in the place and form of an excretion. The very nature of the cambium, in fact, and especially its adaptation to pass into all the principles of the several and widely different parts of a plant, imply that any of it which passes out at the radical extremities is unsuited to either leaf, flower, bark, stem, or root, differs in quality from the retained, proper, or assimilated juice of them all, and is, therefore, in the strict and even offensive sense of the word, an excretion.

Another defect of Mr. Gyde's experiments, and one which they share even with those of M. Macaire, is that they took no account of the play of chemical affinities within the soil. Land plants inserted in pure water, as were those of Mr. Gyde's principal series of experiments, or even plants inserted in water holding saline matters in solution, as were those of one of his subordinate series of experiments, cannot possibly have the same aliment or make the same excretions as plants growing in soil; they are under totally unnatural conditions as to at once mechanical support, electrical agency, ammonical and oxygenic supplies, the elements of their food, and the preparatory elaboration and exoteric digestion of their aliment; they feed in different circumstances, on different things, and with different preparation,—all on the side of both diminishing the amount of their excretion, and very greatly substracting from its grossness; and they probably are just as far from excreting like plants growing in soil as an animal fed for a week on gum and water would be from excreting like an animal fed on miscellaneous, strong, nutritious food.

But a third error in Mr. Gyde's experiments, one far more serious than even the preceding, was their almost totally overlooking the solid excrement of plants in the form of dead rootlets and dead radical epidermis. Exceedingly little of this solid excrement can be given out to water in the course of from 3 to 15 days insertion in it of a fully-formed or maturing plant,—the only conditions under which Mr. Gyde allowed himself an opportunity of obtaining it; yet the quantity of it given out to soil, though hitherto unascertained or even proximately calculated, must be very great. Consider the crumbling and peeling of the epidermis of roots as illustrated by the crumbling and peeling of the bark of ligneous stems, and remember that the scores or hundreds or thousands of rootlets of a growing plant are in a continual process of decay and reproduction, and you will conclude that the radical deposit of solid dead matter within the soil cannot but be aggregately bulky. Now this solid matter—though never yet, so far as we know, separately obtained and analyzed—can scarcely fail to be far more grossly and perhaps far more mischievously excremental than the mere liquid excretions examined by Mr. Gyde and M. Macaire. Roots regarded in the aggregate are—with the exception of fruits and seeds—more remarkable than any other class of organs for the variety and power of their proximate principles; and, in particular, they, in multitudes of instances, abound in precisely such acrid and astringent matters as are most hostile to the alimenting of the other organs, or of the general system of the plants; and they appear to diffuse odours through the soil, and therefore to impart to it hot and pungent properties, far more by depositing the cast-off portions of these matters than by excreting the liquid refuse of their cambium. Mr. Towers, like the other experimenters, discusses only the liquid excretions, and treats them as involving all the phenomena and all the consequences of vegetable deposit in the soil; yet when he comes to treat of the emission of aroma from the roots, he stumbles upon the fact of solid excretion, and is induced to dispose of it as a seeming hindrance to his doctrine, when he might have exhibited it as both a prop and a mighty part of it. "I wish," says he, "to meet an objection which may be started; it is this: We admit, many may say, that soils about the roots of plants, whether they be confined to pots, or free in the open plots of the garden, emit peculiar odours; but do not these arise from the roots themselves, and not from matters exuded by them, and dispersed among the particles of the soil? I am prepared to grant that the roots as well as the flowers of a vegetable may possess specific aromas; but these cannot be diffused unless they be first emitted. The fact of diffusion, and that to an extent which renders them perceptible to the distance of many inches, or even feet, is demonstrative of the hypothesis of exudation—that which is disseminated must be first given forth: this admits of neither hesitation nor doubt. If, then, the ground be embued with odorous matter transmitted by the porous system of the roots; or if it be admitted, that the odours arise from the very substance itself of millions of fibres broken off, and retained by the soil, which cannot by any art be separated from it, the argument is still one and the same: for it is a matter of pure indifference (provided the ground become saturated with any specific substance) whether that substance be gaseous or solid, whether it have been transmitted from the plant, or produced by admixture with broken and lacerated portions of the vegetable body itself."—On the whole, then, the excretion of plants is quite a sufficiently serious matter to demand the attention of gardeners and farmers, to enter largely into their scientific views of the arts of cultivation, and to occupy some space in their calculations respecting the most efficient rotations of crops; and it continues to be so obscurely or partially understood as to be abundantly worthy of more searching and comprehensive investigation on the part of phytologists.—*Mémoires de la Société de Physique et d'Histoire Naturelle de Genève.*—*Lindley's First Principles of Horticulture.* — *Towers' Gardeners' Manual.* — *Edinburgh New Philosophical Journal.* — *Liebig's Chemistry of Agriculture.*—*Transactions of the Highland Society.*—*Quarterly Journal of Agriculture.*—*Loudon's Gardeners' Magazine.*—*Davy's Agricultural Chemistry by Shier.*

EXECUTOR. In law, one appointed by a man's last will, to carry its provisions into execution after the testator's death. The testator may, by the English law, appoint any person of sound mind and discretion, though under some legal disabilities, as to contracting and transacting business in general, such as a married woman, or a minor. The duties of executors and those of administrators are, in general, the same, the difference of the two depending mostly on the mode of appointment, the executor being nominated by the testator, the administrator being appointed by the judge of probate; and often an administrator is appointed to administer upon an estate under a will, as where the testator does not name an executor or where the executor named declines, or where the executor or administrator first assuming the trust has died, or is discharged by the court, where administration on the estate has once been granted and commenced, and, before it is completed, a new appointment is necessary, the person so appointed is called an *administrator de bonis non*, "with the will annexed," if there be a will. The administrator, with the will annexed, assumes the duties that would have belonged to the executor, if one had been appointed, or if the one appointed had acted, or had continued to act. Though a testator is at liberty to appoint any person to be his executor, with some few exceptions, the judge of probate is restricted, in the appointment of an administrator, whether it be the one on an estate of a person dying intestate, or "with the will annexed," and whether it be the one originally appointed, or the one appointed *de bonis non;* for the widow and nearest of kin to the testator have a right to the appointment, unless they are under some legal disability. The statutes more generally provide, that the nearest of kin of the age of twenty-one shall have the administration, either jointly with the widow, if there be one, or on her declining, or on there being some legal objection to her appointment. By other statutes on this subject, it is left to the discretion of the judge of probate, of the orphan's court, or of the magistrate, whoever he be, having this jurisdiction, to appoint either the widow or the next of kin. The principal creditors of the deceased are next entitled to this appointment. But a liberal discretion is generally vested in the magistrate as to this appointment. The same judge who appoints the administrator has the power of revoking the appointment.

An executor *de son tort*, that is, an executor of his own wrong, is one who meddles with the administration of the goods of a person deceased, without any authority so to do, and he is accordingly answerable to the rightful executor, or administrator, when one is appointed. It is the duty of an executor, or administrator, after the will is proved, if the estate is to be administered under a will, to give notice of his appointment, make an inventory of the estate, and return it to the probate office or court; to take care of the personal property of the deceased, and see that it is not wasted; to collect the debts due to the estate, and, finally, to distribute the effects or their proceeds among the creditors, until their demands are paid, and then among the heirs and legatees, according to the directions of the will of the deceased, or according to the dispositions of the law, in case of its being the estate of a person dying intestate, or what is called, in the civil law, an estate *ab intestato.* In collecting the effects and debts, and so in investing the proceeds pending the administration, the executor, or administrator, for the most part, acts according to his own discretion; but in making a distribution of them among the heirs or legatees, he is particularly directed by the judge of probate. In the former case, he accordingly acts at his peril, and is liable, as are also his sureties, for his managing the estate with proper discretion; but in distributing the effects and proceeds, he acts under a judicial decree, and so is secure from any personal liability.

EXERCISE. By this term we commonly understand the amount of bodily motion necessary to maintain the proper circulation of the fluids, and to impart that degree of activity which the natural condition of the animal body requires. Exercise is the contrary of repose, and without either of these, the animal machine would soon be destroyed. It greatly assists the insensible transpiration, the most abundant of all the secretions, and keeps off a number of diseases depending upon the superabundance of the fluids, their impurity, or stagnation, enlargements or obstructions of the viscera. Far from diminishing the animal forces, it reanimates them; a languishing appetite is restored, and the consequences of exercise are reflected throughout the entire vital economy. The influence of exercise upon fecundity and longevity are not less remarkable. Very fat animals are often unfruitful, while a long-continued repose frequently leads to obesity, which again induces impotence, and often death. These are not the only consequences of a continual want of exercise. Their limbs are deprived of that play and spring necessary in preserving all the parts of the body in their state of health.

Exercise should, however, be regular and moderate. Very violent labour may affect all the organs, and render the stature diminutive; hence all excess in this respect should be avoided if possible, especially during the growing period of life. The domestic animals require much attention in respect to their lodgings. When in their wild state, they are constantly in the open air; in their domesticated condition they are often abstracted from it. This essential difference necessarily affects the conditions of their existence; and, in proportion as they are brought nearer to their natural state, their health becomes improved, while an opposite course of treatment may be attended with the most fatal consequences.

Our most useful domestic animals are often confined in narrow stables, which are perhaps rather injurious than beneficial, from their vicious construction or pernicious arrangement. A knowledge of these defects has suggested to some rural economists the idea of exposing their cattle continually in the open air; but these persons do not perceive, that in avoiding one error they fall, as frequently happens, into another not less important. When in their wild state, animals are always *in the open air*, it is true; but it does not follow that they are continually *exposed to the weather*, which is a very different circumstance of their condition. In their native haunts, they always endeavour to withdraw themselves from excesses of every kind, whether of heat or cold, moisture or dryness, as well as from storms, tempests, violent winds, or the attacks of their enemies, while they are free to change, whenever they please, either their place or position. It therefore becomes a serious error, through inattention to these circumstances, to expose domestic animals to the inclemencies of the weather, without the slightest shelter, for the mere purpose of avoiding the common disadvantages of a stable. We have often seen flocks of sheep shut up in narrow parks, exposed in winter to the frost, in summer to the burning heat of the sun, in spring and autumn to excessive moisture, and in all seasons to the sudden changes of the atmosphere, and consequently to the most sudden alternations of temperature. The natural consequences of this mismanagement have invariably followed, while their undue mortality and impoverished condition fully demonstrated, that animals exposed to all kinds of weather, are far from being in that state of nature to which it was intended to reduce them. Their amelioration, their prosperity, and even their existence, are compromised as much by this injudicious treatment, as they would have been by the most confined, uncleanly, and ill-constructed stable.

It is no doubt true, that we should endeavour to bring animals to a real state of nature, and place the enjoyments of liberty and fresh air as much as possible within their reach. Yet this can only be done effectually by giving them the power, whenever circumstances permit, of going alternately, under cover or in the field, by having some enclosed space where they may be free to move, and with a sufficient number of retreats or sheltered spots, to which they can resort at those times when there is more real inconvenience and disadvantage in being without than within. This is the only legitimate way in which we can approximate the domestic animals to their natural condition.

EXFOLIATION. The process of forming and expanding leaves in the natural growth of plants; also, the process of absorbing the living portion of a carious bone in the natural functionary life of animals.

EXOCARPOS. A genus of Australian shrubs and trees, of the tribe Osyrideæ. They have flexile twiggy branches; and form their seed on the outside of a fleshy receptacle. The cypress-shaped species, *E. cupressiformis*, is an evergreen timber-tree of 40 or 50 feet in height, and was introduced about 20 years ago to the hothouses of Britain. Two species of ornamental shrubs have also been introduced; and several other species are known.

EXOGENS. The great primary division of plants whose increments of growth are added to their circumference or formed exteriorly to their central cylinder. All are dicotyledonous. See the article DICOTYLEDONOUS PLANTS. They comprise all the native trees of cold climates, and also a considerable proportion of those of the tropics. The wood of many of them, when seen in a cross-cut or horizontal section, very generally exhibits a number of concentric circles corresponding to the years of the plants' growth. See the articles WOOD and AGE OF PLANTS. The radicle of their seeds, in the process of germination, does not require to pierce through an enveloping membrane, but simply lengthens at its point; and hence the exogens are designated by some botanists exhorhizæ. The leaves of exogens generally, though not quite uniformly, differ from those of endogens, in being stipuled, in having ramified or retiform veins, and in falling clean off from their attachment; and their flowers, in the great majority of instances, have four-membered whorls or five-membered whorls or multiples of these, while the flowers of the greater number of endogens have their whorls upon a three-member type. See the article ENDOGENS.

EXOSMOSE. A counter current to endosmose, or the passage of a more dense fluid through animal or vegetable membrane into a less dense fluid. See the articles ENDOSMOSE and ABSORPTION.

EXOSTEMMA. A genus of evergreen, tropical trees, of the cinchona division of the madder family. The many-flowered species, *E. floribundum*, grows wild in the West Indies, has a height of 40 or 50 feet, and is used as a timber-tree; and it was introduced about half a century ago to British hothouse collections. Three other species, smaller than the many-flowered, and all ornamental, have also been introduced; and about a dozen other species are known.

EXOSTOSIS. A tumorous enlargement of the bones of animals. It is occasioned by morbid increase in the secretion of bony matter; and sometimes degenerates into a malignant and fatal osseous fungus. It occurs in various bones, and possesses a very various character. Blaine describes exostosis in the horse as remote and proximate, as mediate or immediate, as principally caused remotely by pressure and proximately by inflammation. Some of the chief varieties of exostosis in the horse, bearing distinct names, and usually treated as so many distinct diseases, are splint, bone-spavin, ring-bone, curb, and anchylosis. All exostoses ought to be early attacked; for even when dealt with promptly and by the most powerful appliances, such as local stimulants and internal action of iodine, few are ever completely cured or more than tolerably alleviated.

EXOTIC. An appellation for the produce of foreign countries. Exotic plants are such as belong to a soil and climate entirely different from the place where they are raised, and therefore can be preserved for the most part only in greenhouses. Exotic plants of the hot climates are very numerous, and require the utmost attention of the gardener. Even if they can be brought to blossom, it is rare that they produce fruit, and still more rare that the seeds ripen. It is only by care and accurate observation of their nature and wants, that some of them can be *acclimated*, or made to flourish on the foreign soil.

EXPANSION. In physics, the enlargement or increase in the bulk of bodies, in consequence of a change in their temperature. This is one of the most general effects of heat, being common to all bodies whatever, whether solid or fluid. The expansion of solid bodies is determined by the pyrometer, and that of fluids by the thermometer. The expansion of fluids varies considerably; but, in general, the denser the fluid, the less the expansion; thus water expands more than mercury, and spirits of wine more than water; and, commonly, the greater the heat, the greater the expansion; but this is not universal, for there are cases in which expansion is produced, not by an increase, but by a diminution of temperature. Water furnishes us with the most remarkable instance of this kind. Its maximum of density corresponds with 42°·5 of Fahrenheit's thermometer; when cooled down below 42°·5, it undergoes an expansion for every degree of temperature which it loses; and at 32°, the expansion amounts to $\frac{1}{180}$ of the whole expansion which water undergoes when heated from 42°·5 to 212°. With this more recent experiments coincide very nearly; for, by cooling 100,000 parts in bulk of water from 42°·5 to 32°, they were converted to 100,031 parts. The expansion of water is the same for any number of degrees above or below the maximum of density. Thus, if we heat water 10° above 42°·5, it occupies precisely the same bulk as it does when cooled down to 10 degrees below 42°·5. Therefore the density of water at 32° and at 53° is precisely the same. Dalton cooled water to the temperature of 5° without freezing, or 37°·5 below the maximum point of density; and, during the whole of that range, its bulk precisely corresponded with the bulk of water the same number of degrees above 42°·5. The prodigious force with which water expands in the act of freezing, is shown by glass bottles filled with water, which are commonly broken in pieces when the water freezes. A brass globe, whose cavity is an inch in diameter, may be burst by filling it with water and freezing it; and the force necessary for this effect is 27,720 pounds weight. The expansive force of freezing water may be explained by supposing it the consequence of a tendency which water, in consolidating, is observed to have to arrange its particles in one determinate manner, so as to form prismatic crystals, crossing each other at angles of 60° and 120°. The force with which they arrange themselves in this manner must be enormous, since it enables small quantities of water to overcome so great mechanical pressures. This observation is conspicuously illustrated by observing the crystals of ice on a piece of water exposed to the action of the air in frosty weather; or upon a pane of glass in a window of a room without a fire, at the same season. Various methods have been tried to ascertain the specific gravity of ice at 32°; that which succeeded best was to dilute spirits of wine with water till a mass of solid ice put into it remained in any part of the liquid without either sinking or rising. The specific gravity of such a liquid is 0·92, which, of course, is the specific gravity of ice, supposing the specific gravity of water at 60° to be 1. This is an expansion much greater than water experiences even when heated to 212°, its boiling point. We see from this that water, when converted into ice, no longer observes that equable expansion measured by Dalton, but undergoes a very rapid and considerable augmentation of bulk.

EXPECTORANT. A medicine or medicinal appliance which promotes the discharge of morbid mucous secretion of the air-passages of animals, and in consequence relieves cough and difficulty of breathing. Watery vapour, whether simple or medicated, is the only expectorant which acts directly or by immediate contact with the affected organs; and all the other expectorants—exceedingly great in number and variety, and gathered from among sedatives, vegetable stimulants, balsams, gum-resins, and other classes of substances—are swallowed like food or condiment, and can operate on the affected organs only by sympathy or by some other obscure mode of action. Expectorants for the human subject, as in the instance of many of the popular and quack nostrums for common coughs, are sometimes so ill-chosen as to occasion great eventual injury to the patient. "In the horse," says White, "the action of expectorants is not easily perceptible. It has been said, that as a horse breathes only through his nostrils, the effect of such medicines (if they had any) would be shown by a discharge from the nostrils; and as they are not observed to cause such discharge, they must be ineffectual. But in coughing, air is expired by the mouth, and it is not improbable that mucus may be discharged by the lungs at the same time, though this point is difficult to be ascertained with precision. I am convinced, however, that some of the medicines termed expectorants, frequently prove serviceable in the horse, by relieving or curing cough and difficulty in breathing, or what is termed thickness of wind; among these are squill, and gum ammoniacum; both which I have often found very beneficial in those complaints, although I cannot say in what manner they operated."

EXPERIMENT. A trial of the habits of plants, the chemical affinities of substances, or any other matters of scientific practice, with the view of ascertaining properties or effects hitherto unknown. Experiments in the chemistry of agriculture, or in the phytology of agricultural plants, even when conducted upon principles of penetrating and far-sighted theory, are subject to so many mistakes, oversights, and disturbances, and make appeals to the joint agency of so many recondite forces and ill-understood agencies, that they very often prove utter failures. Yet they generally elicit some incidental good; and when even one in a thousand of them is completely successful, it may confer upon the whole community lasting and incalculable benefit. "One happy result which can generally improve the methods of cultivation," remarks Sir Humphrey Davy, "is worth the labour of a whole life; and an unsuccessful experiment well observed, must establish some truth, or tend to remove some prejudice."

EXPERIMENTAL FARM. A farm devoted to the ascertaining of the best properties of agricultural plants and stock animals, and of the adaptation of new varieties of them to the uses of ordinary farms. An experimental farm of merely 200 or 300 acres in extent, cannot afford scope and facilities for any proper experiments whatever in tillage, for almost any experiments in the breeding and rearing of stock, or for one-tenth of the most common or ordinarily desirable experiments upon agricultural plants; an experimental farm of any size managed by second-rate agriculturists, or laboured by second-rate or inferior workmen, can neither throw a competent degree of science and skill into any of the experiments, nor command the confidence of ordinary farmers in their results; and an agricultural farm of even the best possible character, as to at once amplitude of extent, variety of departments, and superiority of management and working, is intended solely for the improvement of agricultural science and the enlightenment of persons already well acquainted with its principles, and affords no proper opportunities for instructing and training farm-apprentices in the elementary arts of common husbandry. The many proposals which have been made to establish experimental farms within similar limits to those of experimental gardens, or as practical schools for the training of young men to the profession of farming, are utterly preposterous. An experimental farm, in the true and only workable sense, would be a high benefit to the general cause of agriculture; but it would require vast resources, and could be established and maintained only by a very great and liberal institution devoted entirely to its own interests. The following ideal of one, extracted from an article in the 36th Number of the Quarterly Journal of Agriculture, is instructive, and will not be regarded by any comprehensive thinker as chimerical:—

"Fixing each division for cropping to comprehend five acres, which, in our opinion, is the least extent of ground upon which a plough and pair of horses would have the freedom to work as they would on a farm, and if the division comprehended ten acres so much the better,—there is little difficulty in ascertaining the whole space which a given number of crops would occupy under a regular rotation. Taking only four varieties, each of wheat, barley, and oats, for experiment at one time, the crops in the rotation with them will be found to occupy nearly 1,000 acres imperial. The various seeds which would be cultivated for other purposes than grain, would occupy, we presume, other 1,000 acres; for it must be held in remembrance, that they also must be cultivated in divisions which the plough must operate upon. It is not so easily foreseen what extent of ground the live stock would require. What with grazing, top-dressing, and experiments on various kinds of pasture grasses at different elevations, the space must be considerable. Soiling grass in summer, and turnips and other roots in winter, would be partly furnished by the grain divisions; but with all these assistances, we conceive 2,000 acres would be required, one-half in the hill, and the other half in the plain. But as experiments should be tried with black-faced sheep, small black cattle, and horses, on heath pasture in summer, 2,000 acres would not suffice for this department. The plantations dispersed in different situations over the farm would require 1,000 acres; and bog and muir land a couple of hundred acres. Thus, the experimental farm should comprehend 5,200 acres to do justice to every subject which ought to be experimented upon. As the farm would contain 2,000 acres of good and tolerable land, we conceive that 20s. an acre would not be an over-estimate of its value, that is, at a yearly rent of £5,000, regardless of the value of the bog and muir land. As to the stocking and buildings, their value would probably be not less than £20,000; although it is probable much of the live-stock, and many of the implements of husbandry, would be contributed in donations by agriculturists. The annual expenses of such an establishment would be difficult to estimate. There must be much hand-labour, for which women are peculiarly adapted. There must also be many superintendents, possessed of thorough practical knowledge. Acute observation should be the principal characteristic of these superintendents; for on accuracy of observation and correctness in recording results, the value of the experiments as an incentive to imitation mainly depends. The manager of such a farm should be a man of no common attainments. In him perfect science and perfect practice should 'meet together.'—To many this estimate of the size and cost of an experimental farm will appear extravagant. Thus estimated, it is certainly a costly establishment. But when the multiplicity of objects which claim its attention are considered, its extent will be found not to be overstated. Some think 500 acres would answer the purpose. Why, if all the objects which should be found in an experimental farm were merely accommodated with growing and standing room, that space would not be able to contain them. Minute experiments on the progressive development of plants through the influence of manure and climate, may be interesting investigations to the botanical physiologist, and such primary experiments are absolutely requisite to establish the excellence or worthlessness of plants, and they would not occupy much ground; but to stop short at this stage, and not pursue the culture of plants on a scale commensurate with the operations of a farm, would be to render the experimental farm of little avail to practical husbandry and the interests of farmers. There may be difficulty in the research, but we conceive that a farm of the extent required could be found, although all the land might not, perhaps, belong to the same landlord. Such a farm, rendered highly fertile by draining, manuring, liming, and labour, and plenished, as an experimental farm should be, with all the varieties of crops, stock, implements, and woods, would be a magnificent spectacle. What a field of observation for the botanist and physiologist, amongst a multiplicity of objects subservient to experiment! What a laboratory of research for the chemical analyst and compounder in every possible variety of earths, manures, plants, and products of vegetation! What a museum of objects for the naturalist to acquire the living habits and instincts of animals useful to man, and hurtful to the fruits of his labour! What an arena of skill for the practical husbandman to exercise his ingenuity in varying the modes of culture! What an object of intense curiosity and wonder to the rustic labourer! Above all, with what interest and solicitude would the patriot contemplate the appliances of such a mighty engine set in motion to work out the problem of agricultural prosperity!"

EXPOSURE. The slope of a field or garden, or the aspect of a wall, in reference to the sunshine and the prevailing winds. It is as various as the points of the compass. A slope or aspect toward the south is called a southern exposure; a slope or aspect toward the east is called an eastern exposure; and so of the other points. A south by eastern exposure, or a south-south-eastern exposure, is esteemed the best for a garden, on account of its commanding the play of the morning's sunshine, and affording protection from the violence of westerly and south-westerly winds. A southern exposure of clay land is excellent, and ranks next to a south-south-eastern exposure; but a southern exposure of thirsty arenaceous land, though extremely well suited to winter crops, is apt, in dry hot summers, to draw down upon its vegetation a withering and burning drought.

EXPRESSED OILS. Those which are obtained from bodies only by pressing, to distinguish them from animal and essential oils, which last are, for the most part, obtained by distillation.

EXTRACT. When chemists use this term, they generally mean the product of an aqueous decoction. In pharmacy, it includes all those preparations from vegetables, which are separated by the agency of various liquids, and afterwards obtained from such solutions, in a solid state, by evaporation of the menstruum. It also includes those substances which are held in solution by the natural juices of fresh plants, as well as those to which some menstruum is added at the time of preparation. Now, such soluble matters are various, and mostly complicated, so that chemical accuracy is not to be looked for in the application of the term. Some chemists, however, have affixed this name to one peculiar modification of vegetable matter, which has been called *extractive*, or *extract*, or *extractive principle;* and, as this forms one constituent part of common extracts, and possesses certain characters, it will be proper to mention such of them as may influence its pharmaceutical relations. The extractive principle has a strong taste, differing in different plants: it is soluble in water, and its solution speedily runs into a state of putrefaction, by which it is destroyed. Repeated evaporations and solutions render it at last insoluble, in consequence of its combination with oxygen from the atmosphere. It is soluble in alcohol, but insoluble in ether. It unites with alumine, and, if boiled with neutral salts thereof, precipitates them. It precipitates with strong acids, and with the oxides from solutions of most metallic salts, especially muriate of tin. It readily unites with alkalies, and forms compounds with them, which are soluble in water. No part, however, of this subject, has been hitherto sufficiently examined. In the preparation of all the extracts, the London Pharmacopœia requires that the water be evaporated, as speedily as possible, in a broad, shallow dish, by means of a water-bath, until they have acquired a consistence proper for making pills; and, towards the end of the inspissation, that they should be constantly stirred with a wooden rod. These general rules require minute and accurate attention, more particularly in the immediate evaporation of the solution, whether prepared by expression or decoction, in the manner, as well as the degree, of heat by which it is performed, and the promotion of it by changing the surface by constant stirring, when the liquor begins to thicken, and even by directing a strong current of air over its surface, if it can conveniently be done. It is impossible to regulate the temperature if a naked fire be used; and, to prevent the extract from burning, the use of a water-bath is, therefore, absolutely necessary.

EXTRAVASATION. The effusion of any fluids of an animal or a vegetable from its proper vessel into a neighbouring texture or cavity. Extravasation of blood in man, when affecting any of the larger vessels, is in all instances a serious occurrence, and in some instances inevitably and suddenly fatal. Extravasation of blood into the cellular membrane of horses is either an accompaniment of inflammation or an effect of external violence. In the former case, it is reduced to soundness, or perhaps to the condition of a hard tumour, by the cure of the primary disease; and, in the latter, it is either so slight as to be reduced by the natural absorption of the extravasated blood into the system, or so serious as to occasion bad ulceration, and in extreme cases death. Extravasation of gaseous matter into the cellular membrane of the horse constitutes emphysema. See the articles INFLAMMATION, BRUISE, and EMPHYSEMA.

Extravasation of the sap of trees and shrubs appears either in the interior of the bark, or on its exterior, in the form of a resinous matter, a gummy matter, or a sanious water. It is often seen in the resinous form in old wounds or round dead knots in fir timber when sawn up for use; it frequently occurs in the gummy form at the wounds of such drupaceous fruit-trees as have received a 'wind-shake;' and it may sometimes be seen in the watery form, or as a copious liquid discharge, in the wounds of old elms where either living or dead branches have been wrenched away from the stem. Two of the worst and most common forms of it are noticed in the articles CANKER and PLETHORA. A reputed but altogether imaginary form of it is noticed in the article HONEY-DEW. Another reputed but quite unreal form of it is ascribed to a local contraction of the sap-vessels. This is said to occur in trees which have been grafted or budded, and is alleged to be the cause of the apparent swelling by which the scion sometimes outgrows the stock. But the outgrowth is really no sign of disease, and cannot be considered as a receptacle of extravasated sap; for when laid open by the saw, it is found to consist of the same number of ligneous layers as the stock, and to differ only in the comparative thickness or grossness of the deposit of which the successive layers are composed. "Of this fact," says Mr. Main, "many instances might be adduced, as occurring among grafted trees, when the stock and graft are dissimilar in constitution. That gum is often seen oozing from the swollen part is quite true; but this is from bruises, which this projecting part is more liable to than any other part of the trunk."

A frequent and exceedingly exhausting kind of extravasation is the flow of sap from wounds. The intentional withdrawal of sap is practised upon many trees, particularly upon vines, birches, sugar-maples, and many kinds of palms, for economical purposes; and the quantity of sap thus obtained, without any serious injury to the plants, is, in some instances, wonderfully great. But this operation is technically called either bleeding or tapping, and cannot be regarded as the infliction of disease, or as a proper extravasation. But when intentional tapping is unduly prolonged or allowed to become morbid, or when a wound or contusion is inflicted on a tree which cannot afford to lose any of its sap, and especially when any incision is made in early spring previous to the full development of the foliage, sanious water or some collection of other foreign matter is almost certain to effect a lodgment, and to cause local swelling and perhaps constitutional languor and disease. "The best mode of checking such exudations," says Mr. G. W. Johnson, "is by placing a piece of sponge, dipped in a solution of sulphate of iron, upon the discharging place, covering the sponge with a piece of sheet lead, and binding it on firmly. The sulphate acts as a styptic, promoting the contraction of the mouths of the vessels; the sponge encourages cicatrization; and the lead excludes moisture."

EXUVIÆ. This term among naturalists denotes the cast-off parts or coverings of animals, as the skins of serpents, or those of caterpillars and other insects.

EYE. The organ of vision. It is possessed by all the active species of animals, except the few which live in darkness and do not need it; and, in every instance, from its largest size in man and quadrupeds, to its minutest and microscopic form in the smallest insects, it is a museum of wonders, a collection of complicated organizations, a system of intricate and multitudinous adaptations, a mimic universe of the results of design and wisdom and beneficence on the part of the Creator. To describe it fully would require a volume; and to trace all its mechanisms, its adaptations, its chemical relations, and, above all, its evidences of the being and perfections of its Divine Framer, might fill volumes enough to constitute a library. We must refer for general information upon it to technical works and special treatises; and we feel obliged to restrict ourselves to a few sentences, in close connexion with the immediate design of our work.

The eye of quadrupeds, though usually somewhat different from the human eye in form, and sometimes widely different from it in appendages, strictly resembles it in structure. The eye of the horse is proportionally larger than that of some other quadrupeds; it is situated less in front and more to the side than in man, in order to command a wider lateral range of view; its pupilar opening is elliptical, and has the long axis parallel to the horizon, so as to increase the lateral field of vision; and its edge is provided with a peculiar plum-coloured fringe, which is supposed to absorb occasional excesses of light. The horse has excellent vision; and, though not a nocturnal animal, can see better in obscure light than man. His eye, when healthy, is full, clear, dark-coloured, and nearly circular; and when eminently good, it is comparatively large, yet not over-prominent. But this important organ in the most valuable of the domestic animals, is so frequently obscured, defective, or totally blinded from disease, as always to require close examination on the part of the purchaser of the horse, and special tenderness and care on the part of his owner. "If," says Mr. Winter, "the eyeball is sunk into the orbit, producing a corrugated appearance of the lids, we may suspect latent disease. If a horse shies, we should be doubly careful in our examination of these organs, as this habit often arises from defective vision. Some horses, usually with a considerable quantity of white about the face, have what is termed wall-eyes. In these cases, the iris is found to be deficient in its natural colour, giving a white appearance to it. They are not known to be more liable to affections of the eye than those in which this peculiar defect is absent; but certainly it does not increase the beauty of the animal." A horse whose eye exhibits more than a normal proportion of white, has generally a vicious temper. The principal diseases which attack the eyes of horses are amaurosis, cataract, inflammation, ophthalmia, and filaria.

The eye of the ox is situated more on the side of the face, more in a situation to command a wide lateral field of vision, than even in the horse. "The ox in a state of nature," remarks Youatt, "being exposed to the attacks of ferocious animals, needs an extended field of vision in order that he may perceive the approach of danger from every quarter. He is oftener the pursued than the pursuer, and therefore requires a lateral instead of a somewhat forward direction of the eyes. The eyes are prominent, in order to increase the field of vision; and they are rendered thus prominent by the mass of fat which is accumulated at the back of them. A prominent eye is reckoned a good point in a beast; it shows the magnitude of this mass of fat, and therefore the probability of fat being accumulated elsewhere. This prominence, however, should not be accompanied by a ferocious or unquiet look; for breeders have agreed that neither the grazing nor the milking beast can have too placid a countenance, or be too quiet or docile in her habits." See the articles BREEDING, CATTLE, and COW. The roof of the bony cavity which the eye of the ox occupies, is very strong in order that it may resist fracture from the many accidents to which he is exposed; yet, mainly in consequence of the brutal treatment which flocks very generally receive from herdsmen and drovers, it actually, in not a few instances, suffers fracture. Exostoses on the walls of the cavity, and wounds in the fleshy accompaniments of the eye and even in the eye itself, are also not infrequently occasioned by blows, probings, pronging, and goring. "What," significantly exclaims Youatt, "would become of many of our oxen that are driven to Smithfield, and whose heads are covered with contusions, if that hour were not near which delivers them from the barbarity of man!" The other diseases which attack the eye of the ox, and also the eye of the sheep, are nearly the same as those which occur in the eye of the horse. See the articles AMAUROSIS, CATARACT, INFLAMMATION, OPHTHALMIA, BLINDNESS, and FILARIA.

The eyelids of both horses and cattle, but especially those of the latter, are exceedingly subject to accidents and annoying ailments. When the eyelid of a horse is so cut by accident as to be cloven, dissevered, or even partially disparted, the lips of the cut should be stitched together with a straight needle, yet not drawn tightly together but merely brought into contact, and not properly sewed but merely attached by a single stitch. When more stitches than one are made, so as to purse the lips of the wound together in the way practised by some old-fashioned farriers, they will probably break in twenty-four hours, and leave the wound in a worse condition than at first. In the judicious treatment of all wounds of the eye and its appendages, the main care is to prevent or abate inflammation by means of fomentations and poultices, and to make no more manipulations or artificial applications than are barely necessary to coax the constitution into the work of self-healing, and to prevent obstructions from being thrown in that work's way. Soft fungous tumours about the eye or eye-socket of either ox or horse, can be removed only by the use of the knife in the hands of a very skilful operator. Scaliness round the edge of the ox's eye, or a series of pustules similar to what is called stye in the eye of man, may be removed by a cautious use of white vitriol wash, goulard lotion, or nitrated ointment of quicksilver.—*Winter's Horse in Health and Disease.*—*White's Veterinary.*—*Gibson's Farriery.*—*Blaine's Veterinary.*—*Youatt's Works.*—*Clater's Cattle-Doctor.*

EYE-BRIGHT,—botanically *Euphrasia*. A

genus of herbaceous, ornamental plants, of the figwort order. The officinal species, *Euphrasia officinalis*, is an annual weed of the pastures of Britain. It possesses great beauty, and abounds in dry heaths and upland sheep-walks. It loves to cower among heath and grass, and will not grow in gardens or among plants of taller stature than itself. Its stem is hard, four-cornered, and from 2 to 6 inches high; its leaves are flat, broad, bright green, and indented; and its flowers are small, white, and spotted or streaked with dark colours, and bloom from July till September. This plant is eaten by sheep and cattle, but is refused by swine. It was formerly held in esteem by herbalists for the preparation of a healing and strengthening eye-water; and it thus obtained the name of eye-bright, and conferred that name upon the whole of the genus to which it belongs; but it has completely lost its medicinal reputation. A dwarfish, slender, and richly coloured variety of it occurs in some parts of the Scottish Highlands; and a large-flowered and somewhat purple-tinted variety is found on the Alps.—Three hardy annual species,—the flax-leaved, 10 inches high, with purple-flowers,—the alpine, a foot high, with yellow flowers,—and the yellow, 20 inches high, with yellow flowers,—have been introduced within the last 30 years from continental Europe; and nearly thirty other species have been botanically described.

EYELID. See Eye.

F

FABA. See Bean.

FABIANA. A recently discovered genus of ornamental, tropical plants, of the night-shade family, but possessing the habit of the heath order. The imbricated species, *F. imbricata*, is a small, bright-green, Chilian shrub, somewhat resembling a tamarisk or an arbor-vitæ; and when in bloom, it is loaded with snow-white flowers resembling those of some of the heaths.

FABRICIA. A genus of ornamental, evergreen, Australian shrubs, of the myrtle tribe. Four species, yellow-flowered and about a yard high, have been introduced to the greenhouses of Britain. They possess considerable affinity to the superb genera eucalyptus and callistemon.

FACE. The front of the head of man, of quadrupeds, and of some other animals. The face of the horse, as compared to the cranium, is larger than that of the ox; and the face of the ox, as also compared to the cranium, is larger than that of the sheep. The lower portions of the frontal bones which constitute the upper part of the face, are considerably longer and descend much lower in the sheep than in the horse; and they form the roof of much of the nasal cavity of the sheep, and make almost a right angle just above his orbit, while they descend in quite a straight direction in the horse.

FACTOR. See Agent.

FÆCES. See Excrement.

FAGGOT. A bundle of the spray of hedges, the thinnings of coppices, or the pruning of woods. It may be of any convenient size, and may be applied to any one of many economical purposes; but it is usually tied with a twig of hazel or willow, and used either by bakers or for ordinary fuel.

FAGARA. A genus of tender evergreen trees and shrubs, of the rue family. The Pterota, *F. pterota*, called by Thunberg *Xanthoxylon pterota*, is a timber-tree of the West Indies, carrying green blossoms in autumn, and usually attaining a height of about 25 feet; and both this species, and two tall, white-flowered, shrubby species, have for a long time been cultivated in British collections. Several introduced species formerly classed as fagaras are now assigned to other genera; and between a dozen and a score of unintroduced species are known to botanists.

FAGONIA. A genus of curious, evergreen, undershrubs, of the bean-caper family. The Cretan species, *F. cretica*, was introduced to Britain about a century ago from Candia. Miller calls it the thorny trefoil of Crete. Its branches spread close to the ground, and extend on all sides to the distance of a foot or upwards; its leaves are opposite, trifoliate, oval, plain, and smooth; two pairs of spines come out at each joint of the branches, immediately below the leaves; and a single, five-petalled, bluish-purple flower, comes out at the same place as each pair of spines, and blooms from June till August. Two other species have been introduced; and seven or eight more are known.

FAGOPYRUM. See Buckwheat.

FAGUS. See Beech.

FAIR. A periodical concourse of people, at a stated place, for the selling and buying of commodities, for the hiring of servants and labourers, and for indulgence in holiday amusements. One class of ancient fairs were annual assemblies on the festivals of patron saints, held in the vicinity of the saints' shrines, and drawn together by the cupidity of bishops and abbots for the exaction of tolls, and by the licence of fun and riot under the pretence of religion ; and another class were great provincial concourses at times most suitable for general business, held on moors or commons or other open tracts in the centre of the provinces, and drawn together by the rudeness of the commercial circumstances of society, and for the purposes of the most miscellaneous traffic or of universal marts. Many remnants of the former class still exist in various parts of Ireland, particularly in the remote and most Romish districts, under the name of "patterns" or patrons; and several gigantic remains of the latter exist at Leipsic, Frankfort-on-the-Maine, and other places on the Continent of Europe. The holiday class gave rise to the very name of fair, which is simply an anglicisement of *feria*, the Latin word for holiday; and they probably imparted that name to all sorts of stated concourses in the open air, in consequence of the speedy and general blending of holiday amusement with every kind of business. So late as the second decad of the 16th century, fairs continued to be the principal scenes of traffic in some districts of England which are now studded with market towns ; and, down to the present day, they continue to be the grand marts for all merchandise in some of the remote parts of the Scottish Highlands.

Some fairs of the present day differ little from the Irish "patterns;" but others are provincial and almost national marts for farm-stock and agricultural produce; and most differ from regular weekly markets, principally in being larger and more infrequent. Almost all business fairs possess importance to farmers ; and some constitute their chief or perhaps their only opportunities of effecting profitable sales or purchases of stock. Yet very few are sufficiently known beyond their immediate neighbourhood to do efficient service to the general interests of agriculture. Reports of them ought to be as minute, exact, comprehensive, and in all respects statistical as those of the best corn-markets; they ought, in all cases of live stock, to state the numbers usually exposed to sale, the precise breeds which compose these numbers, the proportions of the different breeds, the districts which supply them, and the districts to which they are driven ; and they ought, in every instance, to be made up by impartial, competent, and authorized individuals or bodies, so as to be free from the mischievous colourings of prejudice and interest. Excellent notices of the Scottish fairs—though far too long to admit of any useful abridgment within our limits—are given in the 26th, 27th, 31st, and 36th Numbers of the Quarterly Journal of Agriculture.

A fair cannot legally be held at any place without either express permission from the Crown or such prescriptive right as is supposed to rest on some ancient grant which has passed out of record. Yet any fair or market which has been statedly held during twenty years becomes legal by mere force of usage. A fee for leave to set up a stall in any fair is due to the owner of the soil, and may be recovered by him without the formality of an agreement. The raising or propagating of any false report with the view of forcing up prices at a fair is an offence at common law. Two old English statutes provide that the superior of a fair shall maintain an open place for the sale of horses, that a book-keeper shall be appointed by him to receive tolls and make entries respecting horses from two hours before mid-day till sunset, and that this official shall note the particulars of each sale, including the marks of the horse and the names of the seller and the purchaser.

FAIRY-RING. A circular belt of mushrooms and of deep verdure on heathy ground or on hilly pasture. The mushrooms appear only in autumn; but the deep verdure appears more or less throughout the year, and is so conspicuous as to arrest the attention of even a careless observer, and so curious as to have evoked theories from both the superstitious and the philosophical. Some fairy-rings are quite small; but all the more conspicuous are several yards in diameter. Popular belief, throughout the middle ages and down to a recent period, ascribed them to the midnight revels of elves or fairies. Dr. Darwin ascribed them to circular discharges of electric fluid from the clouds. But Wollaston, Withering, Smith, Dutrochet, Turpin, and other distinguished fungolists ascribe them, though not all upon the same principles, solely to the growth and habits of fungi. Wollaston taught that fungi cannot grow in two successive seasons on one spot ; that on rising from any spot of a heath or a pasture on which their spores have incidentally fallen, they exhaust it of all nourishment for their own order, but deposit within it a very rich mass of nourishment for grasses ; and that, in consequence, they extend their own range from year to year outward, and are followed by a belt of rank and deep-green herbage, luxuriating upon their previous year's deposit, and exhausting it in a single course of seasons. Withering promulges a closely similar theory ; and remarks that only one species of mushroom is ever concerned in making any one fairy-ring. Davy seems entirely to adopt Wollaston's theory, and adduces it, in illustration of the doctrine of the rotation of crops, as the most remarkable known instance of the powers of vegetables to exhaust the soil of certain principles necessary to their growth. Waring nearly agrees with Withering ; and observes that the herbage within the fairy-circle is usually very rank, and abounds with the sweet vernal grass and the common daisy. The theory of Dutrochet and Turpin, as reported by Keith, is more elaborate, possesses considerable scientific interest, and throws much light on the obscure and difficult principles of mushroom-cultivation. The growths from the deposited sporules of a field mushroom, are small threads or branches, immediately below the surface of the soil, and in the direction of horizontal rays. "These, as they extend, join by anastomosis, and branch off and join again, till they form a sort of net-work of fibres resembling the skeleton of a leaf. This, in *Agaricus campestris*, is the spawn which gardeners deposit in mushroom-beds as the rudiments of their future crop; which plexus M. Turpin designates by the name of thallus, the mushroom itself being merely the fruit. Now this fruit, which is produced towards the circumference of the rays, comes of course in the form of a circle which, for the first year, is very small; and when it decays and dies, the central part of the thallus decays and dies along with it, giving, by their joint decomposition, a temporary fertility to the soil, with a deeper tinge of green to the grass that grows on it. Hence the first circular superficies of green. But while the thallus thus dies by the centre, it still lives and elongates by the circumference, carrying the fruit further from the centre every succeeding year, and thus enlarging the circle. Where the fertility is exhausted, which was communicated to the soil in the first year of the plant's growth, the centre resumes its original and paler hue, and the shade of deep green is confined to the circumference, where it assumes the form of a circular belt, as it is usually to be met with in our green fields or meadows."

FALLOW. The cleaning and fertilizing of land by a season of pulverization and of special exposure to natural chemical action.

Theories of Fallowing.—The theories of fallowing are exceedingly various, and in some instances violently conflicting. A few well-informed agriculturists regard all fallowing, in any circumstances whatever, as useless and wasteful; a larger number regard it as useful in some circumstances, and mischievous in others; and the great majority, though on much diversity of principle, and with wide differences of opinion as to its precise operations, regard it as, in some form or other, essential to the continuous fertility or the periodical renovation of all arable land. Some define fallowing, "the clearing of the land from weeds, that the future crop, whatever may be sown on it, may possess the whole energy and strength of the soil." De Candolle defines it as "consisting in this,—that every three or four years, a certain portion of land is left completely vacant, or, as it is said, at rest; and this year of rest is devoted to labours more or less multiplied." Sir Humphrey Davy describes it as "a very ancient practice, still much employed, in which the soil is exposed to the air, and submitted to processes which are purely mechanical." Liebig says, "*Fallow*, in its most extended sense, means that *period of culture* during which a soil is exposed *to the action of* the weather, for the purpose of enriching it in certain soluble ingredients; in a more confined sense, the time of fallow may be limited to the intervals in the cultivation of cereal plants,—for a magazine of soluble silicates and of alkalies is an essential condition to the existence of such plants." Professor Rennie says, "Light seems to be the principal agent in benefiting land during the process of fallowing; and as the grass-bleacher must keep his linen wetted or moist, to insure the full effects of the sun's light in whitening his cloth, so must the fallowing farmer have his ploughed land somewhat moist, to insure the full effect of the sun's light in rendering the soil paler by decomposing the dark excrementitious matter." Rham, less speculatively, but with reference only to the broadest varieties of the practice, defines fallow as "a portion of land in which no seed is sown for a whole year, in order that the soil may be left exposed to the influence of the atmosphere, the weeds destroyed by repeated ploughings and harrowings, and the fertility improved at a less expense of manure than it would be if a crop had been raised upon it." Sir John Sinclair, with the comprehensiveness of view which generally characterizes his agricultural descriptions, treats a fallow as too multitudinous in its modes of action, or as too diversified in both its principles and its effects, to be reducible to any summary definition. Not a few other distinguished writers might be quoted on fallowing, some identifying its power with a single mode of action, others extending its power over a vast and very diversified range, and all differing more or less from one another, and from those now quoted, in their views of its precise nature and effects.

Advantages of Fallowing.—Though all the alleged advantages of fallowing are denied by the small number of agriculturists who condemn the entire practice as useless, and though each in turn is denied by some one or other of the many conflicting theorists upon the subject, yet the great majority are real, and possess more or less importance, and deserve, for the sake of making a due impression on the farmer's mind, to be brought succinctly together into one view. All, however, are not realized in any one set of circumstances, or in each kind of fallowing; the greater number belong, in their full sweep, either to the summer-fallowing of clays or the green-crop fallowing of loams; and a few, in certain peculiarities of soil and climate, and particularly on silicious lands with droughty weather, pass totally from the character of advantages into the opposite character of evils.

Mere rest to land permits the accumulation of humus from the growth and decay of natural herbage, the storing up of carbonaceous matter by the fixation of carbonic acid from the atmosphere, the disintegration of the alkaline and aluminous principles of the soil, the reception of nitrogenous matter from rain water and the droppings of birds, the accumulation of phosphates, sulphates, and other products of animal manure from the droppings and carcasses of birds, vermin, and some smaller animals, and the preparation of the specific food of wheat and other choice agricultural plants by the general combinations of the mineral disintegrants, the organic deposits, and the atmospheric gases. The most ancient and sacred fallow of all, therefore —that which the Divine Being enjoined in the Mosaic law upon the Israelites, "Six years shalt thou sow thy land, and shalt gather in the fruits thereof, but the seventh year thou shalt let it rest and lie still"—was mighty in benign tendency, and combined, in the circumstances of ancient Palestine, the play of a highly fertilizing power with the practice of an exceedingly simple cultivation. Many modern writers, indeed, deny the beneficial effect of the resting of land; and some even speak of it with ridicule and derision. Kent, for example, says, "Those who talk of resting land seem to consider it of the nature of an animal, which undoubtedly must have rest as well as food, to go through labour;" and Professor Rennie, in the same strain, says, "Unless we should fancifully endow the soil with nerves and muscles, whose energy might be exhausted by exertion, this doctrine of rest would never account in the slightest degree for the well-ascertained effects of fallowing." But land resting in fallow rests merely from cultivation; it rests only from the surrender of those scarce and peculiar principles which nourish agricultural plants, and which furnish through them the proper food of the higher animals; it rests principally from the evolution of phosphates, sulphates, silicates, and ammonia; it does not rest absolutely; it conducts both its chemical and its vegetative process with as great and ceaseless activity as ever; it experiences change, not at all in the amount, but only in the direction and the result of its energies; or, to allude to the metaphor of Mr. Kent and Mr. Rennie, it suspends for a little its exhausting labour, not that it may recruit itself by sleeping, but that it may renovate itself with feeding and with natural exercise. The fertilizing power of the resting of land in this sense—the only sense ever seriously thought of —seems to us almost axiomatic, and may be proved by the self-recovery of districts which had been abandoned to desolation,—by the self-restoration of lea-fields which had been over-cropped and scourged to exhaustion,—by the concurrent testimony of ancient husbandry among the Israelites, the Greeks, and the Romans,—by the "perpetual soils" of the American forests and prairies, —by the progression of natural vegetation, from the lichen or the sphagnum or the scanty herbage, up to the richest grasses or the most massive trees,—by the necessary and natural accumulation of exuviæ, animal deposits, and vegetable remains,—by the nature of humus,—by the very formation of soil,—by the original fixation from the atmosphere of all the vast masses of carbon in the crust of our world,—by the results of the disintegration of rocks,—and by nearly all the mighty processes of natural chemistry which occur in the mutual reactions of the earth and the atmosphere. Sir Humphrey Davy, with a self-contradictiousness, sadly out of keeping with his usual style, asserts that fallowing acts in a purely mechanical manner, and that it "affords no new source of riches to the soil," and immediately adds, "It merely tends to produce an accumulation of decomposing matter, which, in the common course of crops, would be employed as it is formed." *Merely* produces this *accumulation!* Why this is everything which fertilization either means or requires; for, if his words have any meaning, "the accumulation" effected by the fallowing rest consists wholly of the very matters which feed the ordinary crops of the farmer. Sir Humphrey's general philosophy was too powerful for his particular theory upon the resting of land; and it burst up through that theory, and welled over the top of it, in spite apparently of his very consciousness. Theorists may say what they please; but practical men, from the most scientific farmers of Norfolk or the Lothians down to the bog-trotters and the con-acre-men of Ireland, know that the resting of land is fertilizing. "Vegetable aliment," says Brown in his Report of Derbyshire, "can only be restored by fallowing and rest." "Every good Wiltshire farmer," remarks Davies in his Report of Wiltshire, "will say that, upon the downs, two years' rest for wheat is equal to the best coat of dung. Dung may give the quantity, but rest must give the quality."

The destruction of weeds by all the varieties of broken or tillage fallowing is regarded as one of their chief advantages by most agriculturists, and as their sole, or almost their sole, advantage by some. Marshall says, "Be it known even to all men, the main purport of fallowing is to destroy weeds;" and many distinguished writers hold precisely similar language. The perfect facility which the turnip husbandry affords for keeping light soils in a state of constant cleanness, and for destroying all weeds upon them in the mid-summer season of their rankest growth, is the reason why the alternation of green crops with white crops upon such soils serves the same purposes as naked or summer fallowing upon heavy, clayey, wheat soils; so that the destruction of weeds is a circumstance so controlling as to determine the specific character of tillage fallows, or to divide them into the two great classes of naked and green, in adaptation to the two great prevailing classes of arable lands. Yet a few agriculturists regard the destruction of weeds by fallowing as either uneconomical or altogether chimerical. Brown of Markle, for example, contends that one hand-picking will destroy more weeds than two ploughings; and Lawrence, the author of the New Farmer's Calendar, maintains that couch-grass, one of the very worst weeds which infest our corn-fields, is actually propagated by fallowing. But nearly all the worst weeds, including couch-grass, docks, coltsfoot, and the perennial thistles, cannot be hand-picked at all, and either strike their roots too deep or ramify their radicles too broadly to be even unseated by any process short of an upturning and pulverizing of the whole body of the soil; and any weeds, such as couch-grass, which resist the destroying efforts of a single season's fallowing, can be subdued only by a subsequent smothering with grass, so as to prove the necessity of prolonging the tillage fallow into a fallow of rest, and of aiding the latter with an artificial sowing of pasture-grasses. Inefficiency of fallowing to destroy weeds is frequently alleged by supine farmers and superficial observers; yet the real inefficiency, in any case in which it seems to occur, is, not at all in the principles or the intrinsic power of the fallowing, but in the slovenliness, the incompleteness, or the brevity of the operations. "Whenever a state of foulness or a want of tillage returns," remarks Marshall, "he must be an ignorant or an improvident husbandman, and unfit to partake in the cultivation of a circumscribed territory, who neglects to repeat the operation of fallowing,—not by merely summer-fallowing, but by continuing a course of tillage, through every season of the year. The great and prevalent error in fallowing, is that of closing the operation when it is barely beginning to produce the required effect. The root-weeds having broken into sets, and the seeds of weeds released from their confinement, they are left alive in the soil to propagate their respective species, and contend with the crop to be placed in conflict with them. One ploughing toward the finishing of a fallow, may be more radically efficacious in regard to the complete extirpation of weeds, than three or four at its commencement; —a regenerating process this, which, in a course of years, will do more for the occupier, the proprietor, and the community, than all the plausible schemes of amateurs, listeners, and superficial observers, added to all the quackery of interested individuals, that has so long been poisoning the minds, and debasing the practice, of inexperienced occupiers."

The other advantages of tillage fallow may be briefly enumerated. The soil is pulverized, mellowed, and rendered thoroughly friable and porous. The roots and other remains of vegetables are converted into soluble food for succeeding crops. The eggs, embryos, and burrowing adults of insects, molluscs, and the other small animal pests of the field, are destroyed partly by mechanical and chemical actions, and partly by exposing them to the attacks of rooks and of other birds. All obstructions to perfect tillage may be readily removed; and the surface so levelled and adjusted as to prevent the stagnation of water, to facilitate future culture, and to maintain friability and porosity in the soil. Full opportunity is afforded for the application, and fair scope given for the chemical action, of caustic lime or of other mineral manures. Opportunity is afforded also for improving the mechanical condition of the soil by the intermixation of sand with clay, of clay with sand, or of calcareous matter with excess of undecomposed vegetable remains. Facility is afforded for the early and effective sowing of winter wheat. A predisposition is imparted to the soil, by the state of its tilth, by the reduction of its humus, and by its freedom from the white snail, to produce after wheat an abundant crop of clover. So great an enrichment of the land is effected by the disintegration of its mineral constituents, the dissolving of its organic remains, the increase of its digestive powers, and the general results within it of chemical and electric action, that one-half of the manure which would otherwise be required, and in some instances less than one-half, is sufficient for the luxuriant growth of all the crops of the following rotation. "This," remarks Sir John Sinclair, "is an object of much importance,—a scarcity of manure being the greatest evil with which the arable farmer has to contend; and this fully compensates for the want of a crop, which is so strongly urged against the fallow system." The accumulation of the saline food of the cereal grasses, from mineral disintegration and chemical action, is the same as in the fallow of mere rest, but vastly greater in amount. "It is quite certain," says Liebig, "that careful ploughing and breaking up of the soil, by producing the change and increase of its surface, exercise a very favourable influence on its fertility; but these mechanical operations are only means to an end. In the effects produced by time, particularly in the case of fallow, or that period during which a field remains at rest, science recognises certain chemical actions, which proceed continuously by means of the influence exercised by the constituents of the atmosphere upon the surface of the soil. By the action of the carbonic acid and oxygen in the air, aided by moisture and by rain-water, the power of dissolving in water is given to certain constituents of rocks, or of their debris, from which arable land is formed; these ingredients, in consequence of their solubility, become separated from the insoluble constituents. These chemical actions serve to explain the effects produced by the hand of time, which destroys human structures, and converts gradually the hardest rocks into dust. It is by their influence that certain ingredients of arable lands become fit for assimilation by plants; and the object of the mechanical operations of the farm is to obtain this result. Their action consists in accelerating the weathering or disintegration of the soil, and thus offers to a new generation of plants their necessary constituents, in a form fit for reception. The celerity of the disintegration of a solid body must be in proportion to its surface; for the more points which we expose to the action of the destructive agencies, the more rapidly will their effects be produced." Advantages of greater or less importance result also from the free play of light upon the frequently altered surfaces of the soil, from the dissipation of the odorous or hydro-carburetted matters of the excretions of plants, and from the thorough intermixation of the portions of soil which long lay farthest removed from light and air with the portions which lay correspondingly long at the surface. The melioration of the soil by the various kinds of chemical action was rather conjectured than known by the former generation of agriculturists, and was pronounced by Sir John Sinclair to "belong to theoretic reasonings and deductions." "This much, however," says that eminent agriculturist, "is certain, that the soil, after a well-wrought fallow, has a mellow and fertile appearance familiar to every experienced husbandman, while that which has only been ploughed up after carrying repeated grain crops, or which has been carelessly and inefficiently fallowed, has a close, coarse, and sterile appearance to the eye. The difference between the crops produced on land managed in these several manners, is not less distinct and remarkable; as, all other things being equal, the well fallowed soil produces a healthy, vigorous, and abundant crop of grain, comparatively free from weeds; while the crop produced on the other is weak and scanty, and often overwhelmed by a multiplicity of weeds, disgraceful to the cultivator, and injurious to his interest."

The Different Kinds of Fallows.—The mere resting of land continues to be practised only in rude states of husbandry; and is very seldom adverted to in the fallow-classifications of the modern or improved system of agriculture.—The continuation of a fallow through several years, in any kind of alternate husbandry, is called a laying down to grass; and comprises all the fertilizing forces of preparatory tillage, of artificial sowing of grasses, of choking vivacious weeds beneath a luxuriant growth of gramineous herbage, of accumulating a profusion of humus from the decaying roots of the grasses, of storing up manurial matter from the droppings of animals, and of concentrating many of the advantages of the old and simple fallow-rest. This complicated and powerfully enriching variety of fallow is totally unknown on many of the best tillage-lands of England, and is regarded by not a few agriculturists as quite at war with the highest principles and the most remunerating practices of rotational husbandry; but it is extensively practised throughout the lowlands of Scotland, as well as in some other districts, and has been found, on all the poor and the second-rate varieties of arable land, to comport, in a long course of years, with more profitable returns than the very best systems of either permanent pasture, or perpetual tillage. About 30 years ago, after a special and very extensive inquiry had been made upon the subject, the President of the Board of Agriculture expressed a decided opinion, that a much larger proportion of the United Kingdom than was then so cultivated might be profitably subjected to the alternate system of husbandry, or transferred from grass to tillage, and then restored to grass. See the articles GRASS-LANDS and ROTATION OF CROPS.

A bare, a naked, or a summer fallow ploughs up the land immediately after harvest, subjects it to a series of cleaning and pulverizing operations throughout winter, spring, and summer, and usually terminates in the sowing of wheat in the following autumn. This is fallow *par excellence;* and is frequently spoken of with as peculiar an emphasis as if no other kind of fallow were known.—A green fallow treats the land on the same principles and throughout the same length of time as the summer fallow; but, instead of keeping it entirely unoccupied, it makes a sowing of some green crop in spring, and renders the hoeing or the general after-culture of that crop an equivalent for the summer portion of the fallowing operations. This fallow is an essential and very prominent member, and very generally a repeating one, in all good rotations on every description of dry arable land; and it even, in a very great degree, has given complexion or distinctive character to all the best varieties of modern husbandry; yet, in consequence of its involving as regular cropping as the constant cultivation of grain, it is often mentioned without any reference to its effects as a fallow, and regarded as simply green-crop culture.—A bastard fallow sows winter-tares or some similar crop after the autumn ploughing, clears away the crop by eating-off or otherwise in spring, cleans and works the ground in summer, and ends, like naked fallow, with an autumnal sowing of wheat. This not only curtails the time and abridges the cleaning operations of a naked fallow, but mars the large and important portion of the chemical action proper to the frosts of winter, and maintains during one half of the period of the fallow the very opposite of those influences upon the soil which are at play in a fallow-rest; and it abundantly deserves its ignominious epithet of "bastard."—A spring fallow is simply an ordinary course of tillage, profusely given, vigorously plied, prolonged far into spring, and immediately followed by the sowing and cropping of barley. The sole amount of it is taking advantage of the late sowing period of barley to give the land a better and a longer tilth than in years devoted to other crops. But, except for dragging out some of the roughest of the weeds, and giving the soil a somewhat better pulverization than usual, it cannot be regarded as having any fallow-power.—An autumn fallow is simply a good working of the land, in favourable circumstances of soil and weather, between the harvesting of the summer-crop and the sowing of winter-wheat; and is, in no true sense of the word, any fallow whatever.—A rag-fallow is a tearing-up and pulverizing of lea-land in summer, in preparation for the autumnal sowing of wheat. It is practised chiefly in Scotland, and seldom even there by any farmer who gives good usage to his land; it involves a risk of rendering the soil too loose for the wheat; and, in any instances in which it might seem to be necessary, it may, with the best possible effect, be superseded by single-furrow ploughing and the use of the presser-roller.

History of Fallows.—In all ordinary cultivation, the ancient Romans appear to have regularly alternated crop and fallow. Virgil recommends that fallow lands, when cropped, should be allowed to rest every other year; and several Roman writers distinctly imply, or almost expressly say, that farmers usually depended on crops taken alternately with fallow, and that, in rare instances, they sowed seed upon land that had carried a crop the preceding year, only from necessity or with the view of raising an extra supply of fodder. Virgil, according to Trapp's translation of him, says,

"Alternate, too, thou shalt permit to rest
The late shorn fallows, and the idle mould
To harden."

And again,

"That tilth at last rewards the greedy hind,
And answers all his hopes, which twice has felt
The sun and twice the frost: by this manure
Harvests immense shall burst his crowded barns."

The ancient Roman practice seems to have been early introduced to England and other countries which were subdued by the Romans; and it continues to the present day to be observed throughout large districts of continental Europe. A barbarous and singular variety of prolonged fallow-rest, or of alternate exhaustion by a series of unmanured cropping and fertilization by long abandonment to the influences of natural chemistry and indigenous vegetation, prevailed in Scotland from the dawn of record, and still survives in a few vestiges round the Highland and Hebridean outskirts of the country. But any kind of worked fallow, or fallow in any sense similar to that of the Romans, the English, and the modern continental Europeans, was unknown in Scotland till about the beginning of the 18th century. The first Scottish instance of preparing for a cereal crop by frequent ploughings and harrowings was practised by John Walker of Beanston in East Lothian, upon a field which is still pointed out to the curious. But many other farmers speedily imitated his example; most in his vicinity fell into the custom of giving a summer fallow to strong soils every fifth or sixth year; and about the close of the first quarter of last century, the practice of summer-fallowing was an established usage of all the best kinds of Scottish husbandry.

The summer fallow, in frequent or periodical recurrence, and in an entirely unmodified form, was long identified, not in Scotland only but in other countries, with the improved or rotational method of agriculture. The grand objection to it was the great cost of labour, unaccompanied for a whole year with even the slightest return of produce; but this was everywhere adjudged to be compensated by the great enrichment of the soil, and by the corresponding luxuriance and value of the succeeding crops. But when the rent of land became increased, when the expenses of cultivation became augmented, and when the productions of the soil permanently rose in value, farmers began to grudge the cost and the immediate unproductiveness of the summer fallow, and to inquire whether it might not be abrogated, or whether at least it might not give place to some cheaper and equally effective substitute. A number of enthusiastic agriculturists made total war upon the fallow, assailed it by a variety of conflicting theories, conducted experiments with a view to prove its uselessness, and became known to the agricultural world as a kind of sect under the designation of anti-fallowists; and some stray descendants of this sect may perhaps still be found, advocating the somewhat recent anti-fallow theories of Grey and Beatson. But though the anti-fallow system bubbled up and died away like froth, the substitute-fallow system shared a very different fate, and has become firmly and generally established as one of the happiest inventions of agricultural genius. The cultivation of turnips and clover, as a substitute for baro fallow, was tried first, and with great success, on the light soils of Belgium and the Netherlands; it was practised next, and with triumphant results, on the light soils of Norfolk; and it rapidly spread thence into the light soils of most parts of Britain, and has eventually intermixed itself more or less with the rotational husbandry of even clay lands. "The advantage of the turnip culture," remarks Mr. Rham, "is so great in light lands, that it has gradually been extended through the different gradations of loams, till it has reached even the colder and stiffer clays, on which it would at one time have been thought absurd to attempt to raise this root. But this has been attended with an important benefit. It has made the cultivators of heavy soils turn their attention to the drying of their lands, by draining and deep tillage, in order to make them capable of bearing turnips; and although the extended culture of this useful root is not what we should recommend for cold wet clays, we highly approve of all improvements which will make such lands capable of bearing good crops of turnips. Unless the turnips can be consumed by sheep on the spot, or by cattle near at hand, without injuring the land in taking off the turnips and carting on the manure, there will be no great advantage in a crop of turnips; and some other substitute must be found for the occasional fallow before it can be altogether abandoned. On light lands, the preparation for the turnips, the abundant manuring, and subsequent hoeing, are as effectual in cleaning the land and bringing it into a fertile state as any complete fallow could ever be; and the clover smothers and destroys the seed weeds which may have come up amongst the barley or oats sown after the turnips." Yet the general excellence of green fallow on even light lands, and especially on loams and clays, is abridged and controlled by important limitations, which will be noticed in a subsequent paragraph on the necessity of summer-fallowing.

The Green Fallow.—All crops which, during the period of their growth, permit the ground to be cleaned and worked nearly as much as in bare summer-fallowing, might, at first sight, appear fully and equally adapted to the purposes of a green-fallow; and, if the destruction of weeds were the only object to be attained, they really would be equally adapted. But, in consequence of the various nourishment which they abstract, of the different excretional and manuring deposits which they make, and of the widely different circumstances of culture which they require, some either possess very inferior adaptation to others, or derive all their ameliorating properties from the accompaniments of their culture. All cultivated crops, whether green or cereal, naturally act exhaustingly upon the soil; and the crops of a green-fallow are made to act in an opposite way, either by being hindered from seeding, or by being sown upon a profusion of durable manure, or by having most of their substance returned back upon the soil, or by such a consuming of them where they grow as occasions great enrichment of the land from the droppings and the treading of sheep and cattle.

All or very nearly all known plants impoverish soil principally during the period of their forming and maturing their seeds; and the cereal grasses owe their chief exhausting effect to the circumstance of their being grown mainly for sake of their seeds; while the best of the fallow-crops are hindered from acting impoverishingly, in consequence of their being grown for the succulent food of either their roots, their leaves, or their stems. The turnip is by far the best of the fallow-crops, and affords, in the circumstances of its culture, the clearest and most complete example of the whole process of working the green-fallow; yet it is not permitted to form its seeds or even to send up its flower-stem,—it returns a large portion of its bulk directly back to the soil,—it admits of any apportioning of durable manure which may seem desirable for the subsequent crops of the rotation,—and, whenever the conditions of the soil require consolidation or special enrichment, it can be eaten off by sheep, so as to occasion the land to be compressed by the contacts of their feet and bodies, and manured with both their solid and their liquid excrements. But if it were incapable of these accompaniments, and especially if it were allowed to remain on the ground till it formed and matured its seeds, even this excellent plant, in spite of the most sedulous hoeings and pulverizings which could be given, would lose its main value as a fallow-crop, and leave the land in a state too exhausted to produce a remunerating crop of wheat, or at least too poor to maintain any ordinary course of rotational cropping. See the article TURNIP.

The beet, the carrot, and the parsnip are equal to the turnip in facilities for manuring and working the soil, and in freedom from the forming of seed or of flower-stem, but are far inferior to it in the manner of harvesting, or in adaptation to consumption on the field. The cabbage, the borecole, the rape, and the cole, when cultivated solely for their leaves, are ameliorating; but when cultivated for their seeds, are exceedingly exhausting. The potato, in the era of its health and vigour, always expanded a profusion of blossom, and matured a corresponding profusion of seed, and it therefore was intrinsically, and in a very great degree, an exhausting crop; yet, in the usual methods and circumstances of its cultivation, with an enormous mass of the richest compost or farm-yard manure, with an abundance of deep and vigorous stirring of the soil, and with a return upon the land of all its haulm, and especially of all its seeds, it acted amelioratingly, and was far from being a bad fallow-crop.

Clover when used for herbage, or cut early for fodder, is ameliorating; but when cultivated for its seeds, is exhausting. The bean is always allowed to mature its seeds; and as it elaborates within these some of the rarest and choicest proximate principles of the seeds of the cereal grasses, it might seem to be outrageously unfit for the purposes of a green-fallow; but with a profusion of rich, short, farm-yard manure preceding or immediately following it, with such wide drills as afford the amplest scope for all the operations of cleaning and pulverizing, and upon such clay soils as abound in alumina, and require every appliance for the increase of their porosity, it is found to be sufficiently ameliorating to serve as a frequent fallow-crop; yet even in these circumstances, or in the most favourable varieties of them, it requires to be occasionally substituted by a bare summer-fallow. Other leguminous plants act exhaustingly or amelioratingly according as they do or do not form their seeds. Hemp and flax, in all the ordinary methods in which they have hitherto been cultivated, are absolute scourges, and cannot alternate with the cereal grasses; yet when taken up early, they are less hurtful; and if all the scutchings, the seed, and the steep-water of flax were carefully collected and returned to the soil, so that nothing should be carried away from the land but the substance of the fibre, flax would have no impoverishing effect, and might become a highly remunerating fallow-crop.

Grievously little attention has hitherto been paid, in the selection either of the fallow-plant itself or of the manure for it, to the precise proximate principles which are abstracted from the soil or added to it; and if a nice calculation were made of the changes which respectively a bare fallow and any given green-fallow effect upon the soil, and care were used so to adjust the latter, through the quality of the plant, of the manure for it, or of the harvest treatment of it, as to make it quite or nearly coincide with the former, then would the triumph of green-fallow as a substitute for bare-fallow be complete. The great mistakes hitherto have been to overlook the disturbance of the chemical action of the bare-fallow by the growth of the fallow-crop,—to keep out of view the compound living action, secretional, excretional, electric, and otherwise, of the growing plants,—to make no adaptation of the kind or quality of the manure to the special necessities of the soil,—and to ascribe the efficacy of fallowing, rather to the mechanical operations upon the soil, than to the chemical influences which these accelerate or call into play.

Necessity for Summer-Fallowing.—A green fallow, particularly with a simple alternation of the turnip and red clover, was long regarded by many agriculturists, and is still regarded by a few, as quite sufficient to render summer-fallowing for ever unnecessary on all sandy soils and light loams. But though the turnip fallow has successfully maintained unceasing cultivation for a long course of years on some peculiarly situated light lands,—though it serves as an excellent substitute for summer-fallow during periods of six or eight or even ten years on many kinds of loam,—and though, with the aids of abundant of putrescent manure, and the most efficient thorough-draining, it can profitably keep up a course of constant cultivation during five or six years on even very stiff clay land; yet, in the present state of agricultural practice, it has been found, in the concurrent experience of the very best farmers, utterly incompetent to supersede summer-fallowing more than during a single rotation on clay lands, or more than during two rotations on ordinary or even light loams. Perpetual cultivation is a very pretty theory, and, in a maturer state of agricultural knowledge, may probably become a still prettier practice; but it has hitherto been maintained on speculative principles which are at war both with recent discoveries of science, and with the eventual findings of experience. Gardeners, indeed, may, at first sight, appear to keep their plots of ground in perpetual cultivation; but they apply a vast amount of rich and very compound manure, they allow exceedingly few of their plants to run to seed, they carry off in the shape of produce little other matter than the plants have elaborated out of the elements of air and water, and they keep up far more than the normal amount of chemical action within the soil by frequent digging, thorough pulverization, and constant aeration; and yet, in spite of all these enormous advantages above such as can be embodied in farming, they are still obliged to practise something like summer-fallowing; for, at stated periods of six or even four or three years, they dig the ground a double spit of the spade in depth, and lay it up in winter to the frost.

The chemical ameliorations effected by summer-fallowing, have, as already hinted, but a partial counterpart in those of green-fallowing; and the principles abstracted or modified or prevented from forming by the green crop, are sometimes very inadequately supplied, or perhaps not supplied at all, by the accompanying manure. But even the mechanical operations of the green-fallow are almost always most mischievously abridged in the case of fallow-crops which require to be sown in the middle of spring, and sometimes not a little curtailed or marred in the case of the very favourable and late-sown turnips. "On strong clay soils, and on lighter soils on retentive bottoms, it is impossible to begin work early in spring in any season, and particularly in a wet one; and if the succeeding weather becomes very dry, which is frequently the case in this country in March, such land gets so hard, that the pulverization of the soil, by harrowing and rolling, which are necessary for effectual cleaning, cannot be accomplished in time for the turnip crop; especially as it is found that a rapid succession of similar operations, on the same piece of ground, does not work the land so beneficially as the same quantity of labour bestowed at intervals would do. Light and air must get time to unite with the soil; and these elements are necessary ingredients in the food of plants. That the season for sowing the green crop may not be lost, it must be sown in whatever state the land may be, if sown at all, on strong lands."

The Agricultural Report of Mid-Lothian states that summer-fallowing is infrequent on light dry soils, but that when repeated at intervals of about seven years on wet or heavy lands, it occasions a greater amount of aggregate profit than the constant use of the green-fallow. The Reports of Staffordshire and Kent state, that summer-fallowing for wheat on cold, wet, or strong lands, is indispensable to the prevention of serious loss. The communications of the Rev. Mr. Headrick to the Board of Agriculture state, that strong clays require a more frequent repetition of summer-fallow than soils which are dry and friable. "No reasons, however ingenious, for the omission of fallowing," says Cleghorn, "can bring conviction to the mind of the farmer, who, in spite of all his exertions, finds, at the end of six or eight years, that his land is full of weeds, sour, and comparatively unproductive. Drilled and horse-hoed green-crops, though cultivated with advantage on almost every soil, are probably in general unprofitable as a substitute for fallow, and, after a time, altogether inefficient. It is not because turnips, cabbages, &c., will not grow on such soils, that a fallow is resorted to; but because, taking a course of years, the value of successive crops is found to be so much greater, even though an unproductive year is interposed, as to induce a preference to fallowing." "Let theoretical writers say what they please," says a writer in the second volume of the Quarterly Journal of Agriculture,—we believe Mr. Henry Stephens,—"and let the expedients of man be what they may in extraordinary circumstances, no man can maintain the fertility and of course the productive powers of his farm, of whatever nature the soil of it may be, for any length of time, and exclude bare-fallowing from the rotation. Let him be as clever a farmer as ever had the management of land, he cannot possibly keep his land clean in this humid climate by continual cropping, a climate which exhibits little fine weather in spring. All the art of husbandmen cannot possibly avert the injurious effects of a precarious climate. That art has undoubtedly accomplished a great deal to ameliorate the climate, but it has its power limited like every other; and here summer-fallowing seems to be a *sine qua non* in the rotation of British and Irish husbandry."

Operations of Summer-Fallowing.—The first ploughing must be given in autumn and before winter. The objects of it are to smother the surface weeds, which would grow in mild weather even in winter, and to expose the lower parts of the soil and the roots of perennial weeds to the frost, by turning up the bottom of the furrow-slice to the air. Stubble land in a green or moist condition is cut clean with the coulter, and turned over uniformly and unbrokenly with the mould-board; but land which has become dry and hard occasions very severe labour to the team, yields its furrow-slice in a broken and jagged manner, and is so irregularly raised from the bottom as to make the surface of the subsoil serrated, and to dispose it for intercepting the percolations of water. If, therefore, the weather in autumn be so dry as to harden the land, the breaking up of the stubble should be postponed till the soil becomes moistened with rain. The laying of the ridges may be done in any one of several ways; but it ought, in each instance, to be adapted to the character and slope of the land, and to the keeping of it dry during the months of winter; and, in whatever form it is done, it must continue in that form till spring. An excellent method in many circumstances, is to cleave with open furrows; and good practice in some circumstances gathers the ridges, and in others casts them. "The advantages of ploughing on good principles are obtained, in the greatest degree, by placing the furrow-slice at an angle of 45° with the horizon; and yet a practice prevails in many places, which decidedly runs counter with this principle, and that is,—of laying a loosened furrow right on its back over the surface of a rib of land which is left untouched by the plough. The appearance of this kind of work is that of very ill-made drills. A free soil, in clean condition, which is not wished to be much affected by frost, may be usefully ploughed in this manner, for the purpose of keeping part of the land firm; but, while the furrow-slice receives all the benefit of the action of the atmosphere, the part upon which it rests is prevented from receiving any advantage. These ribs are generally made across the ridges, or at an angle with them; and, on strong land, they form a sort of receptacle for surface-water. This practice deserves, on every account, to be condemned. Light land, on open bottoms, may be advantageously ploughed, crown and furrow, to lie all winter; that is, what is the crown of the ridge at one time is made the furrow at another. Surface-water will not remain so long on such lands as to do them harm, but may assist to consolidate them, and even to irrigate them. Strong clay-lands, on the other hand, cannot be kept too dry in winter; and, as their ridges have a considerable roundness, the best succeeding furrow that can be given is to cleave down the gathered up ridges, that is, the open furrow of the rounded ridge is still kept the open furrow of the cloven ridge, while the crown of the rounded ridge is made the middle furrow of the cloven ridge, the rounded ridge being, in fact, cloven or split in two. The furrow-slices of a rounded ridge meet from both open furrows in the crown; whilst the furrow-slices of a cloven ridge depart from the crown to both open furrows, where they are prevented closing up the open furrows by the plough passing up between the furrow-slices, which would otherwise meet from two contiguous ridges."

The second ploughing is given in spring, and ought not, even amid the utmost exigencies of that busy period, to be delayed beyond the early part of May. On all dry soils, whether sand, loam, or thorough-drained and well-mellowed clay, this ploughing should be done across the former one, or as nearly as possible at right angles to it; for, in this manner, it most easily cuts the land in pieces, lays open the greatest possible amount of surface to the action of the air and light and weather, and gives the strongest practicable check to the growth of surface weeds and the ramifying of deep-rooted ones. The land thus treated appears to the inexperienced eye to be a confused aggregation of lumps of earth; yet, on account of its very fracturedness and disseverment, it enjoys far more advantage than if it had a smooth and even surface. On stiff, wet land, however, the spring ploughing should be done in the direction of the former ridges,—for if heavy rains were to fall upon such land in the broken and dissevered state of the cross-ploughing, they might so saturate it as to render the subsequent operations exceedingly difficult and comparatively inefficient; and when the spring-ploughing is thus given in the same direction as the winter-ploughing, a third ploughing becomes necessary; and this must be given across the ridges, and early in June. The land, after receiving its cross-ploughing, whether that operation be the second or the third of the series, must be untouched till, in provincial phrase, it becomes "rizzared," or acquires a sufficiently dry condition to be readily pulverized by the harrows, yet without being so hardened as in any degree to resist their action.

The next operation is harrowing by repeated double turns, each double turn at right angles with the preceding one, and the number of double turns three, four, five, or more according to the condition of the land. On stiff soils, with hard and unyielding clods, a heavy roller must, when necessary, precede the harrows in order that it may so bruise the indurated masses of earth as to let the teeth of the harrows freely act upon them. Rolling cloddy land at this season, when the soil is firm and resistive, has always an excellent effect; but when postponed till the soil has become greatly pulverized by abundant working, it does not break the clods but presses them into the soft soil, and removes such seeds and roots of weeds as they may contain beyond the reach of the harrows. The grubber also may, at this time, be very advantageously employed, for aiding the great process of pulverization. At every turn of the harrowing, all roots and fibres of weeds brought to the surface must be carefully picked up by hand, and gathered into a line of heaps, and then forked or thrown into a cart passing along the line, and conveyed off the ground to be mixed with lime, and decomposed into a compost for manurial use in the following year. The burning of the weeds on the spot is a frequent but very inconsiderate practice; for it drives off into the atmosphere a main portion of the proximate principles which might be slowly decomposed into solid manure, and leaves many of the seeds and the vivacious radicles of weeds unkilled, to be afterwards spread abroad with the ashes, and made to propagate a new and abundant race of wasteful vegetation in the land. Every possible exertion should be made, at this stage of the fallow, by the skilful and frequent use of the pulverizing implements, by the sedulous and searching practice of hand-picking, and the careful and vigilant removal of the utmost vestiges of the weed heaps, to remove from the land every fibre and radicle of a weed which can possibly be found; for not only is this the rankest and most vivacious period of the self-propagation of indigenous plants, but even the smallest portions of some of the worst weeds left in the ground will grow, and slowly but surely make themselves the origin of a new progeny of pests.

If drains are required in the field, and if a sufficient quantity of small stones occur in the soil and can readily be cleared away from it to fill them, they may now be formed. Yet drain-making at this period is really out of its proper season, and exposes the land to the serious contingency of having a large portion of its finely loosened materials washed into the trenches by a heavy or prolonged fall of rain; and unless abundance of suitable small stones are on the spot, and a fair prospect exists of a sufficient continuance of dry weather, it will do better to be postponed to a later stage of the fallow. "Large land-fast stones may now be taken out to form foundations to stone fences, or blown with gunpowder. It is not, however, with the gathering of small stones as it is with weeds: the former must be thrown into the cart at once, as gathering them into heaps does not expedite their lifting afterwards, they having, at all events, to be lifted again singly; whereas whole heaps of weeds which have taken great trouble to gather singly, can be put into the cart by a large three-pronged dung fork."

As soon after all this cleaning process as the weather and the other labours of the farm will permit, another course of ploughing and harrowing must follow. "The furrow now given must of course be in a line with the ridges, in order to cut the former furrow, which was ploughed across, and this may be done by ploughing the ridges either singly, or two, four, or six of them together. The latter is fully the better plan, as it serves to keep the land flat, that is, it will not interfere with the future regular appearances of the ridges when they are gathered up. After harrowing this two double turns at least, rolling and the hand-picking of weeds must be repeated with great care; as the weeds being now not so numerous, and many of their roots having been broken by the plough and the harrow, they may be easily overlooked in a hurry. Every visible joint of quicks, and every separate knot of knot-grass must be gathered. Colt's foot, docks, and thistles, must also be carefully rooted out and carried off. Light lands will seldom require more than this ploughing to make them clean, as the weeds in them readily part with the earth from their roots, and rolling will probably not be again necessary. It is almost certain, however, that strong lands will require another furrow, which may be one across like the second, but only the furrow slices of it reversed, or an angle furrow begun at one corner of the field, and continued to the opposite one in an oblique direction to the ridges. In the cross and angle ploughings, and in ploughing the land along the ridges after the winter furrow, spaces for ploughing, called 'feerings,' of generally thirty yards in width, are marked off to save time in ploughing, to avoid many open furrows, and to keep the land level. Harrowing must again follow, and, if necessary, rolling, and hand-picking weeds, and gathering stones must also be repeated. After all these operations have been performed, the land should be clean, if the weather has not been so moist and warm and sunless, as to, encourage, instead of checking, the growth of weeds. It is here necessary to caution the young fallowest in regard to strong clays. Should the weather prove wet, or likely to be wet, it will be improper to risk strong land so long out of the ridge, as if it be caught by much rain in a flat state, it will become soured before it be so dry as to permit the horses again upon it. One cross ploughing may be obtained in the spring, or early in summer; but rather than risk any more, it would be better to plough the ridges together, backwards and forwards, casting them out, and ploughing them together alternately. In this way, the furrows are always kept open for the passage of water. In such a season, it will be vain to attempt to clean land thoroughly. At this stage of the work, the four-horse plough may be advantageously employed on loamy lands that are worn out by miscropping. It will bring up fresh soil, which has not seen the light of day for many years. If the subsoil be a clay which the plough brings up, it will make an excellent mixture with the scourged loam. This is the period of the work, too, for using the levelling-box, an instrument useful in giving a uniform skin to old irregularly ploughed lands, and in filling up small hollows into which water might collect, which otherwise create trouble in cutting many unnecessary channels. An overgrown rich head ridge may be easily and effectually carried a short distance to a poorer part of the field. Up to this period, the preparation of the land for bare fallow and turnips is the same."

The next process is the restoring of the land to ridges; and this is effected by striking a furrow in the line of the former ridges, and gathering up the soil in the manner of crown and furrow. On very light lands, this gathering up may be made to cover both the lime and the farm-yard manure, and to serve for the seed-furrow; on ordinary loams, it must be followed by another ploughing for the seed-furrow; and on stiff clay lands, which have been laid flat and kept so till this period, it not unfrequently must be followed first by another process of harrowing and cleaning, next by a second gathering up, and next by the seed-furrow ploughing. The lime and the farm-yard manure may be applied at the same stage of the process, but with the former in precedence of the latter; or the lime may be applied at a different stage from the farm-yard manure, and either before it or after it. The lime may be laid down in small heaps, at regular intervals between the feerings of the ridges, either after having been previously slacked by artificial application of water, or in lime-shells to be slacked on the spot by the weather; or—what is better—it may be spread out of carts with shovels upon the ridges, and be brought thither from large heaps of it deposited at intervals upon the head-ridges as it had been brought home in shells to the farm. It should be spread in a dry calm day, or at least under little wind, and with that little blowing on the side of the cart; and immediately after it is spread, it must be harrowed in. If spread in windy weather, it will be unequally distributed and partially wasted or misapplied; and if spread otherwise than in a perfectly dry condition, it will not trickle down into the ruts formed by the harrow teeth, and in consequence not mix properly with the soil. When the gathering up into ridges is followed by a separate ploughing for the seed-furrow, the farm-yard manure may most advantageously be applied at the gathering up, and the lime immediately before the seed-furrow ploughing; for the superposition of the lime upon the manure both counteracts the tendency of the lime to sink too deep into soil, and represses the tendency of the manure to rise to the surface and waste itself in aeriform decomposition. The manure is deposited on the land in heaps of equal size, and at equal intervals; and is spread all athwart the ridge, in equal distribution, by means of light three-pronged forks. The ploughs follow close upon the spreading, and cover in the manure by such a gathering up of the ridge as to increase its curvature. The application of the lime, when made separately from the manuring and subsequently to it, may follow in the course of a few weeks; and the seed-furrow is then given by such a shallow ploughing as but very slightly raises the curvature of the ridge. But if the cleaning operations have been completed, and the manure applied toward the end of July, the land lies untouched thence till the eve of seed-time; and it is then thoroughly double-harrowed, limed, and seed-furrowed.

The operations of summer-fallowing, as now described, are generally those upon good, strong, wheat-bearing loams; but they admit of, and sometimes even require, very considerable variations in adaptation to soil, weather, climate, and the specially weedy condition of the land. But when the general principles of fallowing are understood, and the most common applications of them known, they can readily be adapted, by any farmer of the most ordinary perspicacity, to such diversities of circumstances as occur in the different soils of his farm, or in the different weather of successive years. Let no man, however, be so crude in his notions as to estimate the value of his fallow by the number of its ploughings or the aggregate amount of its labour; for one well-timed ploughing may be more efficient than three ill-timed ploughings, and one skilful and careful cleaning than half a dozen boorish and careless cleanings.—*Communications to the Board of Agriculture.—Marshall's County Reports.—Holdich's Essay on the Weeds of Agriculture.—New Farmer's Calendar.—Hayward's Science of Agriculture.—Beatson's New System of Cultivation.—Dickson's Husbandry of the Ancients.—Hunter's Georgical Essays.—Low's Elements of Agriculture.—Sir John Sinclair's Code of Agriculture.—Sir John Sinclair's General Report of Scotland.*

—Davy's Agricultural Chemistry.—Liebig's Chemistry of Agriculture.—Bayldon on Rents and Tillages.—Q. Journal of Agriculture.—Buel's Farmer's Instructor.—Young's Farmer's Calendar.—Mill.—Doyle.—Stephens.—Rham.—The Society of Gentlemen's Complete Farmer.—Chalmers' Caledonia.

FALSE ACACIA. See Acacia-Tree.

FALSE CORK-TREE. See Cork-Tree.

FALSE QUARTER. A diseased condition of the feet of horses. It can scarcely be viewed as a primary disease; but is always a consequence of some other disease. It constitutes a permanent blemish; and is annoying rather from its incurableness than by its severity. The coronary vascular ligament is so far destroyed in one part that a gap or interruption in the line of horn is made, and can never be filled up in the process of secretion; and this gap, in some instances, causes the animal serious inconvenience or even considerable pain. When false quarter seems to be forming, the horn should be pared quite thin and a blister applied; and when the gap is actually formed, the horn of the part must always be kept thin, and such a bar-shoe should be used as will not make any pressure upon the portion of the crust beneath the blemish.

FANNER. See Winnowing-Machine.

FAN-PALM,—botanically *Corypha*. A genus of tropical endogenous trees, of the palm tribe. The umbrella-bearing species, *Corypha umbraculifera*, abounds in Ceylon and in various parts of Continental India, and has for about a century past been a favourite in the palm-houses of Britain. In its native country, it ranks among the most useful of the palms, and usually attains a height of about 100 or 110 feet. Its pith is eaten like that of Caryota urens; its fibre is used for making ropes and small cordage; its leaves open and fold like fans, have a very great size, and are used for writing upon, for thatching, for awnings, for parasols, and for various other purposes; and its roundish, dark-coloured seeds are employed by the fanatics of the sect of Vishnoo as beads. A leaf of this palm was brought about 10 years ago from Ceylon to Britain, measuring 16 feet across its widest spread, fully 11 feet high, and between 38 and 40 feet in circumference; and when expanded in the manner in which the Cingalese use its kind for awnings, it was sufficient to shade a dinner party of six from the rays of the sun. Six other species have been introduced to the palm-houses of Britain during the last twenty-six years; and one of these, in its native country, attains the same height as the umbrella-bearing species, while another soars to the altitude of 150 or 160 feet. About half a dozen other species are known to botanists. A small half-hardy species of Chamærops from the South of Europe, usually having a height of only about 10 feet, and introduced to Britain upwards of a century ago, is popularly called the low fan-palm.

FAR. A kind of grain commonly cultivated by the ancient Romans, seemingly a very hardy and peculiar variety of wheat, but apparently unknown in modern agriculture. It had so persistent a husk or chaff, that it required to be sown with it, could not be separated from it by thrashing, and needed, for culinary use, to be freed from it by toasting. It had six knobs in the stalk, while triticum or wheat had only four; it was the hardiest of all grain, and made the sturdiest resistance to the cold of winter; it flourished, not only on warm and dry soils, but on the coldest and least reduced; and it is represented by almost all the Roman writers on husbandry as most proper for wet clay land, while triticum or wheat was represented as the most proper for dry. A full view of the manner in which the Roman authors speak of it may be seen in the 2nd volume of Dickson's Husbandry of the Ancients.

FAR. An epithet in popular hippology, of the same meaning as "right" in language respecting the human subject. The far shoulder of a horse, for example, is simply his right shoulder.

FARCY. A disease of the lymphatics or absorbent vessels of the horse. It frequently gives a corded appearance to the lymphatics in their course of accompanying the veins throughout parts of the body; and it was, in consequence, mistaken by all farriers down to a recent period for a venous disease, and usually described as developing itself in the form of "corded veins." It is essentially the same as glanders, but is milder, less dangerous, and more easily cured, and has its seat in the upper or cuticular lymphatics, while glanders are seated in the deeper tissues.

Farcy is either local or constitutional. When the virulent matter of glanders or of farcy-ulcer touches or falls upon a wounded or abraded part of the skin, a cancerous ulcer is produced. This ulcer has a fouler appearance than any other kind of sore, thickens in its edges, discharges a thin and glutinous ichor, spreads in most instances with great rapidity, and never possesses a red or healthy colour; the lymphatics around the ulcer absorb its poisonous matter, and become swollen or corded; the glands to which these lymphatics lead become inflamed and enlarged; and eventually small tumours, technically called "buds," and consisting of abscesses formed by inflammatory action, appear in the course of the lymphatics. Up to this point, farcy is strictly local. But when the virus works long enough around the ulcers to pass through the arresting action of the glands, and to be absorbed into the circulating system, the whole constitution immediately becomes more or less affected. The other parts of the body susceptible of its action now become affected,—but in a successive order to one another,—and not always in the same order in different animals or in different countries. The parts first affected are usually those at the farthest distance from the centre of circulation,—the hinder-extremities, the fore-extremities, the face, the lips, and particularly the nose. "The internal parts of the nose," says White, "are generally the first to be attacked; the delicate membrane by which they are lined becomes inflamed and ulcerated, discharging large quantities of matter; the next part which is affected is generally the skin, on various parts of which farcy buds make their appearance, and degenerate into foul spreading ulcers; at length, the bones of the nose become carious or rotten; and finally, the poison falls upon the lungs, and very soon puts a period to the sufferings of the unfortunate animal. Sometimes the progress of the disease is extremely rapid, and destroys the horse in a very short time; at others it is remarkably slow, and continues in the same state for a considerable time, without affecting either the appetite or strength." But the disease, in its constitutional variety, is exceedingly various in character, and often complicated or conflicting in its symptoms; it sometimes is almost or altogether undistinguishable from glanders,—and always has a tendency to pass quite into that disease; it sometimes assumes such a chronic character as to leave its subject to drag out a long and hobbling existence as a drudge; and it seems to present different prevailing initiatory symptoms within the sphere, or at all events in the reports, of different practitioners,—usually commencing, in some districts, in the nostrils,—in others, in the hind-legs,—and in others, in the fore-legs. A common popular name of the local or simply cuticular variety of it is button farcy.

The causes of farcy are similar to those of glanders, but are both more numerous and more varied. The actual application of it to a bare surface, or perhaps to either a mucous or an abraded one, is probably indispensable to the excitement of it; yet this often occurs in so obscure a manner as to elude all possibility of ordinary observation; and, what seems not a little curious, the swallowing of the virus with food or otherwise does not appear to exert any injurious influence upon the stomach, or through it upon the general system. Farcy is peculiarly liable to arise from long continued canker, from a combination of poor food with hard work, from constant dampness and confined air in the stable, from extensive and neglected ulceration of the extremities, and from any other agency or set of agencies which tends to debilitate the constitution. It occurs most frequently either in young horses who have not acquired the firmness and strength of maturity, or in old horses who have lost their vigour and are passing into the last stages of senility. A feeble animal readily contracts it from even a slight touch of its virus; but a strong, healthy, middle-aged animal completely resists the most copious inoculation.

All varieties of local or button farcy which do not commence in the mucous membranes of the head, if timeously attended to, were formerly thought to be easily and summarily curable, and certainly are in many instances really cured, by the simple application of the cautery,—the ulcers speedily throwing off the slough, presenting a red and healthy appearacce, and evincing a readiness to heal rapidly in the manner of common sores. But even these varieties sometimes prove themselves to have sufficient hold of the constitution to resist the effects of cauterizing; and the varieties which commence in the nostrils, pass with such rapidity into the glanderous form as to be incapable of prompt enough topical treatment; while all the varieties which diffuse themselves throughout the constitution, are by far too virulent to be successfully combated by any feebler means than the most powerful stimulants and tonics. A judicious use of the cautery, thorough ventilation, and lubricating and nutritious diet, are essential as auxiliaries; but internal administrations must be made—skilfully, and in well-calculated antagonism to the particular virulence of each case—of such matters as either sulphate of copper in solution with a little gum, corrosive sublimate in combination with vegetable tonics, biniodide of copper without any tonical accompaniment, cantharides in combination with gentian bitters, or such mineral tonics as preparations of antimony or zinc. Washing with lead lotion, and sea-bathing accompanied with a daily dose of salt-water, have, in some protracted varieties of the disease, been found beneficial. See the article GLANDERS.—*Bartlet's Farriery.—Winter's Horse in Health and Disease.—Youatt on the Horse.—White's Veterinary.—Blaine's Veterinary.*

FARCY (WATER). See DROPSY.

FARDING-BAG. The paunch or first stomach of a cow or of any other ruminating animal.

FARDLEBOUND. Indigestion in the third stomach or manyplies of sheep or cattle. It is exceedingly various in at once causes, symptoms, and proper treatment; and it not infrequently has merely a sympathetic character, or is excited and maintained by fever, dysentery, and other diseases affecting either the whole system or the main part of the intestines. The general symptoms of it are distension and constipation,—the former caused by the retention of the food, and by the consolidation of it into a hard, dry, caked mass; and the general remedial appliances are drenches of warm water, searching laxatives, glysters, and cordials. The duration of the disease may extend from three or four days to four or five weeks.

FARE, or FARROW. A litter of pigs,—the number which a sow produces at one farrowing. See FARROW.

FARFARA. See COLTSFOOT.

FARINA. The meal or flour obtained by pulverizing and sifting the seeds of the cereal grasses. The farina of wheat comprises all the portions of the grain used for human food,—not only the finest flour, and the second flour, but also the bran; and the farina of barley, oats, and rye comprises all the corresponding portions of these grains, whether finely or coarsely ground, or even if simply freed from the husks, and prepared for human food. The common epithet "farinaceous food," therefore, simply designates the pulverizable portions of such seeds, whether gramineous, leguminous, or otherwise, as possess a kindred nature to the flour of wheat. Terms closely related to the word farina, and frequently more or less confounded with it, but all designating things which are either comprised in farina or prepared from it, are starch, fecula, amyline, and amidine. Starch is a single proximate principle, constituting a chief ingredient in farina and a considerable ingredient in most esculent roots; fecula is the starchy pulp of either hydrous farina or esculent roots; and amyline and amidine are principles modified out of starch by chemical action, and possessing a somewhat gummy character. Another principle in all farina is gluten; and this, though far less bulky than the starch, is incomparably more important,—the starch serving principally for the current consumption of the blood. and the gluten for general assimilation throughout the system,—so that the richer any farina is in gluten the more alimentary is it as food to man. Now a course of searching experiments and analyses conducted by M. Rodriguez, and undertaken at the request of M. Gay Lussac, proved that the farina of pease, lentils, French beans, and by inference that also of other leguminous seeds, contains a larger proportion of gluten than the farina of the seeds of the cereal grass. "This result," remarks Gay Lussac, "is very important when taken in connexion with their nutritive properties; for it shows that the leguminous farinas united with the potato *L'animalisent fortement*, and render it more suitable for the nourishment of man and beast."

FARM. A portion of land employed in the raising of agricultural produce, whether in the form of live-stock, or in that of prepared animal food, or in that of either edible or economical vegetation. The Saxon word feorme, which was the pristine or uncorrupted form of the word farm, originally signified provisions; it next signified rent in kind, or the portion of provisions which the land-tenant paid to the landowner for the use of his land; and, by a frequent and obvious figure of speech, it finally signified the piece of land on which the provisions were raised, and for which the rent was paid. The word farm, when understood with etymological propriety, can thus designate only such land as is rented or held by a tenant; yet, in ordinary modern usage, it may designate also the home-farm of an extensive estate and the small landed property of any party who is himself both farmer and proprietor.

Different Kinds of Farms.—Farms have a great variety of both character and objects; and are capable of distribution into many classes. The farms of hot countries widely differ in the aggregate from those of cold countries, and at the same time considerably differ among themselves; and even the farms of the vine-district and the maze-countries of Europe, materially differ from those of the regions of barley and oats. But even the farms of Great Brtain and Ireland exhibit much variety, and comprise a number of perfectly distinct classes. The home-farm of a large estate may be conducted either on the principles of sheer profit, or on those of a prime supply of farm produce to the family and immediate dependents of the landowner, or on those of a school or model for the improvement of agricultural practices; and only in the first of these cases, will it present a close resemblance to the hired farms of the same estate. An experimental farm may either be a paltry appendage to an agricultural institution for the training of young farmers, or a vast expanse of ground for testing and improving all sorts of feasible theories in cultivation;.and in either case, it is but remotely similar in most of its practices, and not similar at all in some, to any ordinary farm. A rented arable farm may either be a patch of land, little larger than a mere cottage allotment, or an expanse of land sufficiently large and rich to constitute a valuable estate,—either a piece of bog or moorland, scarcely fertile enough to compensate the cost of working it, or a collection of loams or friable clays or vegetable moulds, everywhere full of energy and teaming with luxuriance,—either ill-conditioned spots of land, scourged with barbarous practices, and destitute of many of the appliances of good cultivation, or a series of fields under the most enlightened system of husbandry, and provided with all desirable implements and natural advantages for maintaining and increasing their fertility; and the one farm, in each of these pairs of characters, is necessarily far different in many of its most important and distinguishing features from the other. Many varieties too of either bad farms or good ones, are produced by differences of climate, of exposure, of georgical history, of facilities of manuring, and of local position in reference to markets.

But irrespective of all these diversities, the farms of Great Britain are distributable into several great and widely different classes, according to the precise nature of the several objects to which they are devoted.—Pastoral farms are employed wholly or chiefly in the breeding and rearing of sheep and cattle. They may or may not comprise arable fields; but, in general, they either have or ought to have as much ploughed ground as will afford sufficient provender from roots and green crops to supply all the deficiency of natural pasture during the winter half of the year. A pastoral farm may be either a mere sheep-farm, in the wildly mountainous parts of a thoroughly highland district; or a cattle-farm, in a verdant valley; or a farm mixedly for sheep and cattle, upon ground of diversified character. All pastoral farms ought to be large; and some are miles in extent.—A dairy farm is employed in producing milk, butter, and cheese; and it may either be of small extent and of mixed character, for supplying the inhabitants of large towns with milk, or of considerable extent and uniform character, for the manufacture of butter or of cheese or of both, or even for combining such manufacture as its main business, with the prosecution of some other department of farming as a subordinate occupation.—A town farm is employed in producing vegetables, esculent roots, and hay and straw, for the use of the inhabitants of large towns; and it may either be a sort of huge kitchen garden for raising articles for the town's green market, or a sort of complicated meadow for the raising of dry fodder for the use of stable-keepers and town cowfeeders.—A carse farm is employed principally in producing wheat and beans, and subordinately in raising such crops as are requisite for wheat and bean farming; and it owes all its peculiarities to the strong and peculiar clayeyness of its land.—An arable farm is employed principally in producing white crops and hay-grasses; and it only so far feeds cattle, or seasonally fattens sheep, as to combine a regular dealing in stock with the systematic and sufficient amassment of manure for the fields.—A mixed farm, or a farm on the system of mixed husbandry, is employed in raising all kinds of agricultural produce, and combines within itself all the chief properties of at once the pastoral, the dairy, the arable, and the carse-farms. The intelligent and well-trained occupant of a mixed farm of from 400 to 1,000 acres is the very beau-ideal of a practical agriculturist, and not only epitomizes in himself the best characteristics of all the other classes of farmers, but escapes some of their disadvantages, and even excels them in the use of some of their peculiar powers. "Rearing cattle and sheep, and having wool to dispose of," remarks Mr. H. Stephens, "he participates in the activity of the stock-farmer. Cultivating grains and the sown grasses, he knows the culture of land as skilfully as the carse-farmer. Converting milk into butter and cheese, after the calves are weaned, and indulging in the predilection for a bit of fine old pasture, he passes the summer and autumnal months as busily as the dairy-farmer. Feeding cattle and sheep in winter on turnips, he attends the markets of fat stock as closely as the farmer in the neighbourhood of a town. Improving on the usual system of farming pursued in arable districts, by breeding and rearing *all* the stock fed on his farm—thereby eschewing the precarious trade of the dealer in stock—thus combining all the kinds of farming within the limits of his farm, he has it within his power every year to suit the particular demand of each market, and thereby enlarge the sphere of his profits; and this he can do in any year more uniformly and certainly than any other class of his co-farmers." Farmers of this pre-eminent and comprehensive class have far more scope, and also more incentive, for promoting the general interests of agriculture than the other classes; and, as this great practical science comes to be better understood, and to approach nearer its recognition as a matter of common interest to all ranks and portions of the community of mankind, they are likely to continue increasing in number till they have all kinds of land in their possession, except impracticable moors and morasses and the stubbornly and irretrievably pastoral hills.

Size of Farms.—A controversy has long existed, and has at times been acrimonious and engrossing, as to the comparative advantages of very small farms and very large ones; and, in consequence of the minutely divided state of land throughout most parts of Ireland, and of the desire which not a few Irish landlords have felt to group their crowds of small farms into large ones, this controversy has often been supposed to involve, to an enormous extent, the comfort, the general well-being, and almost the very existence of a numerous portion of the community. The most common arguments in favour of very large farms are, that they call into play large capitals, that they command the requisite facilities of both science and art for the proper working of the land, that they afford scope for enterprise, and incite the peculiar activities requisite for progressive improvement, that they greatly economize labour and expenditure, and that they evoke both a better and a bulkier produce, and possess a freer and stronger subserviency to the national wealth, and therefore to the common wellbeing. The most prominent arguments in favour of very small farms are, that they reward merit, that they encourage industry, that they keep up and multiply the population, that they promulge a general feeling of manliness and independence throughout the community, that they furnish the best class of men in all subordinate stations of life, and that, in such peculiar circumstances as those of a large part of Ireland, with a crowded population, and without any other general means of support than the cultivation of the land, they are essential to the prevention of extensive starvation and general misery. Some enthusiastic advocates of the minute subdivision of land have even contended that small farms are not necessarily encumbered with any disadvantages whatever, except such as are common to farms of all sizes, that they possess some advantages peculiar to themselves, and that, under almost any kind of treatment, they actually yield a larger produce than if they were consolidated into large farms.

But the controversy is, in a great degree, unmeaning. Either small farms or large ones will produce much or little according as they are or are not worked with energy and skill;

and small farms possess just the same adaptation to men of small capital which large farms possess to men of large capital. A small farm, as is abundantly proved by the small-farm system of Belgium, by many of the cottage-allotment systems of England, and by the strictly analogous character of large kitchen gardens for the supply of the public market,—may easily be so well worked as to yield a maximum of possible produce; and a large farm,—as is proved by the slovenly, wasteful, and semibarbarous condition of much of the farm-grounds in some of the most backward districts of Britain,—may just as easily be so ill worked as not to yield one half of possible produce. In some states of society, such as those of Ireland, almost all farms must be very small in order to afford general maintenance and employment to the community; in other states of society, such as those of the new settlements in Upper Canada and Western America, all farms must be large in order to bring into play the amount of capital requisite for the reclamation of the prairie and the forest; and in other states of society, such as those of England and of the lowlands of Scotland, farms must be of very various sizes, from comparatively small, through all kinds of middle-rate, up to exceedingly large, in order to suit the widely diversified circumstances and capital of the agricultural community. A controversy about the size of workshops and factories in the world of manufacture, would appear to us nearly as wise as the controversy about the size of farms in the world of agriculture. Let interested parties simply observe what arrangement is most desirable in the circumstances of their own portion of the community; and, instead of fomenting discontent and creating disorder by comparing its advantages and disadvantages with those of arrangements in other countries or districts, let them do what they can to push all its parts into the grand and rapid current of general agricultural improvement.

The Renting of Farms.—The hiring or renting of a farm is the most serious professional act of the farmer's life, and requires a nice exercise of judgment. A person who wishes to rent a farm must call all his abilities and professional information into play; he must take a comprehensive and symmetrical view of the numerous circumstances which determine both the intrinsic character of the farm, and its relative adaptation to his capital and knowledge; he must examine alike the advantages and the disadvantages, and assign to each its due or comparative degree of importance; he must discard both a too solicitous prudence, which doubts every benefit, and a too daring courage, which overlooks or lessens every evil; and he must carefully beware of having his choice principally or even partially determined by considerations which are merely incidental, or which do not belong to the real merits or demerits of the farm.

"It must be obvious to almost every person," remarks Dr. Hunter, "that the common farmers often lose themselves in deliberating concerning a farm. They have so many mistaken rules of judging, that they often reject farms, that soon after make the fortunes of such as hire them. In particular, they are very apt to take one false guide, the success of the last tenant. If a man makes a good deal of money upon a farm, or leaves it for a much larger one, numbers will immediately apply, almost without viewing it; but, if a tenant or two breaks, or is poor, most of the neighbours look down upon it, without further consideration. They attribute all to the land, and avoid it, under an idea, that, without a reduction of rent, the farm cannot be profitable. These notions are absurd in the extreme; for the management of various farmers is so essentially different, that success often depends very little on rent. A farmer, with a proper sum of money in his pocket, hires a farm, and thrives upon it; another with an hundred pounds less, hires it, and starves. Suppose two farmers of the same substance, and living upon similar farms,—one manages his land with judgment and spirit, makes all the manure he can, sells no hay or straw, does not injudiciously crop his land, drains his fields, and keeps his fences in good order,—this man grows rich; the other, a sloven in these particulars, falls into poverty. These are the circumstances that make one man rich, and the other poor; the rent has but little influence. And surely it must be apparent, that succeeding occupiers, judging of the respective farms, by the success of others, are taking as blind a guide as they can possibly fix on."

One important consideration is the quality and condition of the soil. The mere colour and mechanical texture of the land, or the general resemblances of its appearance to that of other lands with whose powers of production the party is acquainted, are very insignificant circumstances, and are quite as likely to mislead the judgment as to direct it. Both the elementary constitution of the soil, and the precise condition into which recent cultivation has brought it, ought to be ascertained, the former by analysis, and the latter by searching though courteous inquiry into the method of tillage which has been practised, the course of rotation which has been pursued, the kind of manure which has been applied, and the species and comparative bulk of the weeds which have been encountered. A soil of very inferior constitution may be very similar in both colour and comminution to a soil of very superior constitution; and a soil of mediumly fertile powers, in a state of good heart, will, for a number of years to come, yield more valuable crops than a soil of very highly fertile powers, in a state of rankness from mismanagement, or of exhaustion from the too infrequent repetition of fallow. See the articles SOIL, ANALYSIS, and FALLOW.

Another important consideration is the compactness of the farm, and the convenient distribution of its enclosures. Every farm, in order to be managed with ease and economy, or without an irritating and wasteful expenditure of daily labour, requires to be free from the intrusion of any other man's ground, and free also from intricacy, angularity, and unequal distribution of its own parts. When the fields of a farm are mutually straggling and disjointed, the general business of it is never collectively under the eye, all the operations of tillage and after-culture involve waste of time and labour, the equal distribution of manure is difficult and perhaps impossible, the maintaining of fences is very troublesome and not a little expensive, and depredations of all sorts, by both men and brutes, are comparatively frequent and disastrous. "This I know," says Arthur Young, "I would give a shilling or eighteenpence an acre more for a compact farm than for a disjointed one of the very same nominal value, and this without supposing the evil so great as it is found in many farms. Some lands are so little contiguous as not to be worth, of any man's money, half-a-crown an acre, which, if compact, would be cheap at twelve shillings." See the article ENCLOSURE.

Another important consideration is the nature of the fences, the condition of the gates, and the yearly expense which will be requisite for keeping all the enclosures in a state of efficient repair. Some fences are so incompetent as to entail enormous damage from exposure or depredation; some are so unsuitable, or so positively mischievous, as to impoverish the fields, embarrass the tillage, annoy the flocks, and counteract much of the beneficial effect of draining; and some, though otherwise unobjectionable, may require from the tenant, for their repair or maintenance, an amount of expense which probably may both surprise and distress him. "The nature and state of the fences," remarks Arthur Young, "is a very important article, in so much that it is sufficient alone to render some farms unprofitable bargains which otherwise would be very beneficial ones." See the article FENCE.

A fourth important consideration is the situation of the farm with reference to the public market, to sources of mineral manures, to sources of fuel, to roads, and other public facilities of conveyance, and to the communication of neighbouring grounds. A greater distance from the public market than the majority of farms of similar character, involves the cost of carrying produce the additional distance, and subtracts the amount of that cost from the nett price which the tenant obtains for his produce. Great distance from the sources of mineral manure and of fuel involves a correspondingly great cost in obtaining them; and, in not a few instances, acts as a positive prohibition of lime and coals. Vicinity to abundant supplies of such manures as chalk, marl, calcareous sand, lime, and sea-weed, particularly to the two last, is, in many cases so important, as to render a farm of very middle-rate soil fully equal in value to a farm of the same size and of prime soil in a situation remote from these supplies. Extreme distance from good fuel, as in the Western Islands of Scotland, amounts of itself to a depreciation of 25 per cent. on the gross value of the land; so that a farm at £150 of rent in any such situation, is as high-priced as a farm of the same extent and intrinsic character at £200, in the near vicinity of coal-mines. Ample and free facilities of conveyance, in the form of roads, bridges, canals, and railways, exert so mighty an influence as speedily to raise a starving and barbarous agricultural district to a condition of plenty and refinement; and limited or rugged means of communication from any one farm to the rest of the country, particularly if these means consist entirely of bad roads,—repress enterprise, shut out ameliorating influences, and occasion great wear of vehicles, excessive jading of horses, much irritation of farm-servants, great wasteful expenditure of strength, and an incredibly large aggregate of incidental or general expense. Foot-paths through a farm for connecting neighbouring estates or villages, and turnpike-roads along the boundary of a farm connecting great towns, might seem at first to be trivial matters; but, in multitudes of instances, they act so prejudicially upon several of its interests, as to detract considerably from its value.

A fifth important consideration is the character of the farmery or the condition of the farm-buildings. A brief view of the most desirable form and arrangement of the farmery and its edifices will be given in our article on FARM-BUILDINGS; and this will largely illustrate the present consideration. But the party ought to take into account also the situation of the farmery as to healthiness and adaptation to the circumstances of his family,—the suitableness of the offices, in form and size, not only to the farm itself, but to the peculiarities of his own modes of management,—and the probable sum which he must expend, in an aggregate of years, in order to maintain the several buildings in necessary repair. "All the timbers should be examined; the boarding, brick-work, tiling, thatch, plastering, paving, every article viewed attentively; their duration estimated; and the expense of the probable reparations reduced to calculation. If such cautions are not taken, a man may find himself in a few years in the midst of unexpected expenses; than which nothing can be more fatal, unless he is much stronger than his farm." See the article FARM-BUILDINGS.

A sixth important consideration is the kind and amount of restriction imposed by the conditions or covenants of the lease. The conditions exacted by some landlords, especially when viewed with specific reference to peculiarities of soil, and to improved methods of cultivation, are incompatible with some of the best professional interests of a farmer, and even with the practice of sound principles of husbandry. Stipulations to subject light sandy soils and heavy clayey soils to the same course of treatment,—to refrain from breaking up grass lands, even though some or all of them are in so weedy or thickety a condition as to be more than half useless,—to observe one uniform or unvarying round of rotation upon the ploughed fields,—to abstain from digging up any grass borders of fields,—to consume all hay upon the fields, meadows, or pastures which produce it,—to abstain from feeding off turnips with sheep,—to refrain from sowing some particular crop of much agricultural value, such as oats, rape, flax, or teasel,—these stipulations, and all others of similar tendency, greatly depreciate a farm and embarrass the farmer; and whenever a party agrees to any of them, he ought, in ordinary foresight, to compute the loss of value which they will occasion, and to subtract the sum of that loss from the amount of rent which he binds himself to pay.

A seventh important consideration is the amount of rent. This is, in a great degree, controlled and determined by the other considerations; yet it must be separately viewed, and both minutely and comprehensively examined. The evils of an exorbitant rent are too obvious to require mention, and have been too often and dismally exemplified to need illustration. Four highly controlling elements over rent are the quality of the soil, the duration of the tenure, the stipulations of the lease, and the aggregate of all sorts of current and professional expenses; but another controlling element, perhaps quite as high and yet far from being so obvious, is the amount of capital to be invested in the cultivation. If a farmer can lay out only £4 of capital per acre, he may not be able to afford a higher rent than 10s. per acre; if he can lay out £7, he may pay 14s.; and if he can lay out £10, he may pay 18s. or 20s. See the article Rent.

An eighth important consideration, immediately dependent on the preceding, is adaptation of the size and capacities of the farm to the amount of capital to be employed in its cultivation. Many a tenant is poor and maintains a severe struggle upon a large farm, who might live in ease and comfort, and even acquire a considerable property upon a farm of less extent. A man who possesses less capital than the full stocking and the free working of his farm require, becomes embarrassed at the very outset, and passes through a constant series of varied and harassing difficulties; he lives in penury, in anxiety, and in hard labour; he keeps fewer cattle and accumulates less manure than the state of his land demands; he overworks his horses, and either neglects or abuses a portion of his fields; he sells his produce in any state of the market, and for anything it will bring; and in the first season of poor crops or incidental misfortune, he either becomes insolvent or passes through an ordeal most perilous to both his credit and his health. But a tenant with ample capital escapes all these evils and enjoys the opposite advantages; he is able to work his farm in the most profitable manner, and to take out of it the largest returns which it can produce; he has a ready command of stock, manures, and all other means of enrichment; and he can embrace every favourable opportunity of buying when prices are low, and of selling when they are high. Farmers cannot make transfers of property so frequently as manufacturers and merchants; and, in order to enjoy the same security and realize the same profits as these classes, they require to have a proportionally larger capital. But a farmer who is intelligent, industrious, and frugal, and who makes his payments punctually, and in consequence enjoys good credit, surmounts larger difficulties, and gets comfortably on with less money, than a farmer of different character. Tenants of different kinds of lands, too, and in widely different situations, are able to farm any given extent of surface with very different amounts of capital. The principal circumstances which determine the comparative sum required are the amount of allowance to be paid to a predecessor for portions of crops, manure, and labour left behind him,—the expense to be incurred in the improving of fixtures and in georgical operations,—the degree of necessity which exists for the purchase of lime or of other extraneous manures,—the class to which the farm belongs, whether pastoral, arable, dairy, carse, or mixed,—the comparative poverty or excellence of the soil,—the comparative publicity or remoteness of the situation,—and the aggregate of facilities for making frequent exchanges of property, and for giving free play to a spirit of enterprise. In any average state of things, a farm of 200 acres, consisting of good land, and ordinarily disposed for the joint prosecution of pasturage and tillage, requires a capital of from £1,600 to £2,000.

Other considerations deserve notice; yet all may be bundled together as aggregately equal to only one consideration of importance. The chief of these are the amount of parochial taxation, for the church, the school, and the poor's-house; the amount of assessed taxes and of other national burdens; the price of labour; the exactitude of the farm's measurement, or the manner in which the extent of its superficies has been ascertained; the resources within its limits for the supply of mineral manures or of general composts; the obligation incurred of performing any work or conceding any privilege or usage to the landlord; the kind of supervision exercised over the estate, whether primary or deputed, intelligent or prejudiced, patriotic or tyrannical; the facilities afforded by landlord and agricultural associations for the increase of agricultural knowledge, and the encouragements given to enterprise, experiment, and healthful emulation; and an engagement to terminate the lease under no higher conditions of enrichment in the land or of order in the farmery than those under which the lease commences.—*Young's Farmer's Guide.*—*Hunter's Georgical Essays.*—*Sir John Sinclair's Code of Agriculture.*—*Q. Journal of Agriculture*—*Bayldon on Rents and Tillages.*—*Rham's Dictionary of the Farm.*—*Knowledge Society's Farmer's Series.*—*Farmer's Magazine.*—*Loudon's Encyclopædia of Agriculture.*—*Irish Farmer's Journal.*—*Doyle's Practical Husbandry.*—*Mill's Husbandry.*—*Museum Rusticum.*

FARM-ACCOUNTS. A regular arithmetical record, or systematic and daily course of book-keeping, of all the pecuniary affairs of a farm. The business of a farmer involves as much capital as that of most tradesmen, and is as intricate and complex as that of the great majority of merchants and manufacturers; and it therefore quite as urgently demands a system of minute, comprehensive, and daily accounts. The necessity of book-keeping is so universally felt in all other employments involving the use of capital, that any manufacturer, or merchant, or shopkeeper is utterly astonished when told, for the first time, that it is felt very meagerly throughout an enormous amount of farming, and scarcely felt at all throughout much. Almost all farmers above the grade of mere cottiers, indeed, acknowledge in words the desirableness of accounts; and almost all likewise profess to keep accounts, and to possess a fair knowledge of their own pecuniary affairs; but most, or at least many, content themselves with mere outlines of memoranda; and not a few have really no knowledge whatever of the profit or loss of any of the vast majority of matters which bulk together to constitute their pecuniary condition. "Among gentlemen farmers, it is true," says Sir John Sinclair, "there is often a systematic regularity in all their proceedings; and their pages of debtor and creditor, of expense and profit, are as strictly kept as those of any banking-house in the metropolis. But with the generality of farmers, the case is widely different. It rarely happens that books are kept by them in a minute and regular manner; and the accounts of a farmer, occupying even a large estate, and consequently employing a great capital, are seldom deemed of sufficient importance to merit a share of attention equal to that bestowed by a tradesman on a concern of not one-twentieth part of the value."

Mere general knowledge of the pecuniary condition of a farm, or a knowledge of gross yearly profit or loss in each of its principal departments, is of no value to point out the proper quarters of change, abandonment, retrenchment, increase, or new experiment; nor can it either direct the attention to the precise points which bring profit and to those which occasion loss, or afford information as to the several degrees in which profit and loss occur; while memoranda respecting some crops, or manures, or flocks, or other particular matters, unaccompanied by accounts of the many accessory or incidental costs which affect them, are fitted quite as much to mislead the judgment as to guide it. "If a farmer knows not the degree and amount of his profit or loss on every article and by every field," says Arthur Young, "it is impossible he should possess a due experience of the past, or ever be able to make it a guide to the future. Every common farmer guesses at all these particulars, and acts accordingly, which shows their ideas of the utility of the knowledge. What is experience, but knowing that certain causes have been attended with such and such effects? But what is the knowledge of effects, where a thousand are all jumbled into one account, with nothing but random guesses to form distinctions? Various fields of wheat are managed in a very different manner: is it not of consequence to the farmer to know exactly the product, the expenses, and the nett profit of each? Is he not thereby a better judge of the merit of each method he uses? And will he not be able to manage future crops with more experience than if he had gained none of this knowledge? From keeping such an account of each field, he knows the proportions of rent, seed, labour, wear and tear, &c. and the crop; and sees in what manner the latter answers to the former, and, by a comparison between different fields and modes of culture, is enabled to judge which will probably, in future, pay him best. Two fields of the same soil are cultivated exactly in the same manner, save, that one is manured at a large expense, the other not. To what degree does this manuring answer? Is the answer to this question of no importance? Where is it to be gained, without exact accounts? This instance might be multiplied to ten thousand, in not one of which would experience be clear and valuable, without a regular account. It is the same with grass lands; their products of all kinds; with every sort of cattle. Twenty beasts are annually fattened, that are kept the year through; and twenty milk cows are also kept. Which pays the farmer the best? This is a point of no slight importance; for the difference may be very great; but is it to be known from that general account which every man carries in his head, which is nothing more than an idea? What accuracy can there be in accounts so kept? The farmer stocks himself with two sorts of sheep, ewes, and weathers; they are both fed alike. Which answers best, and to what degree? Even this plain case can be resolved with no degree of certainty, without a regular account being kept of each. When a man turns over his books, and finds a regular balance of profit and loss on every article, he is enabled to review his business, to consider what have probably been his errors, and wherein he has been most successful. The result of such reflections is true experience, not the random notions that are carried in the memory. After some years farming, upon looking over his accounts, he finds that wheat has in general paid him very indifferently; and that, upon an average of all sorts of treatment and seasons, barley, on the contrary, has been attended in the like variety, with a considerable profit. Upon such a review, he finds that his dairy of cows pays him far better than his fattening beasts; that his ewes and lambs are much more profitable than his weathers. He finds by the quantity of work performed by his horse and ox teams, and the expense of each, that the latter are more advantageous, as five to three. This knowledge is beyond all doubt the most valuable part of experience, and can no ways be gained but by regular accounts; for in what manner can such a review of one's business be otherwise made? Will any one be so absurd as to assert all, or any part accurately, can be carried from year to year, for four, five, six, or seven, in the head, and founded originally in nought but conjecture? Nor should fugitive notes and memorandums be called accounts; nothing can effect this great end but a ledger regularly kept. In this light surely accounts may be said to be the foundation of good husbandry, and highly possible to convert a bad farmer into a good one. It is by means of them that gentlemen, in one instance, have so great an advantage over common farmers, as to balance, in a good measure, all the superiorities of the latter. It is by these means that gentlemen may, if they please, gain more experience in five years, than a common farmer can in twenty. Many of them give in to unnecessary expenses, prosecute more experiments than their fortunes will admit, and bring themselves, by degrees, and unknowingly of the amount, into a want of money. A man that keeps regular accounts may certainly do the same; but he must infallibly know how much he so expends, and be warned regularly of the danger; which are points of no slight importance."

Nor ought farm accounts to comprise only a minute record of every field, of every crop, of all manuring, of all farm labour, of all tear and wear, of all dairy produce, of all live-stock, of all farm repairs, and of all matters whatever which in any way figure as items in the grand result of farming profit and loss; but they ought also to comprise full notes of all subtractions from the farm's produce, whether in the form of matters consumed by the farmer's own family and dependents, or in the form of matters given over by barter or donation to other parties, or in the form of other kinds of labour than what are proper to the farm done by the farmer's work-people or by his horses. Even gentlemen farmers, the very class whom Sir John Sinclair lauds for the generally excellent condition of their accounts, require, in not a few instances, to amend their practices on this subject. "If country gentlemen kept regular accounts of the value of all the family supplies derived from the lands in their occupation, and of the works exclusive of farm-work performed by their farm-servants and horses," says Sir P. Murray of Ochtertyre, "it would be proved that the occupation, cultivation, and improvement of land is not so expensive a concern as it is usually conceived to be. The contrary opinion is so prevalent, that it both limits the extent of the farming operations of gentlemen who are engaged in them, and prevents others from engaging in them,—consequences which are much to be regretted, both as limiting and retarding the general agricultural improvement of the country, and as lessening the inducements of landed proprietors and others, to reside in the country, and employ their time and capital towards its cultivation and improvement,—objects which, in every point of view, are obviously of the greatest national importance in all countries."

The farm accounts ought to be balanced, and a valuation of all the stock made, at least once a-year. The balancing of the accounts is essential to the ascertaining of their grand result; and the valuation of the stock is essential to the accuracy, and even to the very act, of the balancing. The decrease of the value of all implements in use should be estimated and noted; an allowance for the increased age and correspondingly diminished worth of all horses should be made; and an estimate of all articles whatever, whether of produce, of stock, of accessories, or of fixtures, should be made and entered, strictly according to their prime-cost market worth at the time of the valuation. All the details of the taking of stock belong, of course, to the accounts of the closing financial year; and only the results of the nett balance upon the whole of the accounts, are transferred to the commencement of the accounts of the next year. The most complete view of all the pecuniary affairs of both farm and farmery throughout the year, if unaccompanied at the end with an annual account of all the live-stock then upon the farm, of the hay and roots unconsumed, of the grain in the granary and the stack-yard, of the implements, and of all other matters in which any portion of the capital is invested, would convey an utterly distorted, a practically false, and a grievously misleading idea of both the amount and the degree of profit or loss upon the farm.

All efficient methods of farm book-keeping, especially on moderate or large farms under the mixed husbandry, embrace a great diversity and a vast multiplicity of items, and are necessarily more or less complex and intricate; and some which have been recommended for general adoption include several departments of no real value, and are far too elaborate for the comprehension, and still more for the use, of a considerable proportion of well-qualified farmers. Yet comparatively easy methods are sufficient for small or simple farms; and any of the more difficult methods, when found requisite, can be mastered by a little application, and are readily comprehensible by any properly qualified clerk. The occupier of a small or simple farm needs only a cash-book for noting all receipts and payments; a ledger for recording all transactions of sale and purchase, of profit and loss; and an inventory-book for keeping a list of all implements, live-stock, produce, manures, and other matters in which capital is invested, and for entering a seriatim valuation of them at the end of the year. Even the most extensive farmer, entangled in all the possible multitudinous affairs of the mixed husbandry, needs only a cash-book, a day-book, a ledger, and an inventory-book,—or at the utmost two additional or separate books for the record of labour and of produce; and if he have never seen any of the special systems of farm book-keeping which have been recommended, he may readily render the common method of book-keeping by double entry, which is taught in all the commercial and parochial schools, available for all the purposes of his accounts. Farm book-keeping, in spite of all the mystery and magniloquence and illusion which have been thrown upon the subject, requires no greater modifications of the ordinary book-keeping of the schools than are required by the book-keeping of many factories and mercantile establishments. Three of the best known special systems of farm book-keeping, are Munro's and Trotter's, both published at Edinburgh, the former in 1821 and the latter in 1825, and 'The British Farmer's Account-Book,' by the author of 'British Husbandry,' published a few years ago in London.—*Young's Rural Economy.—Young's Farmer's Calendar.—Sir John Sinclair's Code of Agriculture.—Transactions of the Highland Society.—Loudon's Encyclopædia of Agriculture.—Stephen's Book of the Farm.*

FARM-BUILDINGS. The farm-house, offices, sheds, and yards of a farmery. When the farm-buildings of a district or country are substantially constructed and well-arranged, the condition of agriculture will generally be found improved, enlightened, and prosperous; and when the farm-buildings are mean, incommodious, and grossly defective, the condition of agriculture will usually be found unimproved and semi-barbarous. About 150 years ago, the farm-buildings of the greater part of Britain were poor, meagre, ill-arranged, and in dismal keeping with a wretched system of husbandry; so late as about 50 years ago, the farm-buildings of some of the best districts were merely in transition from barbarism to refinement; and down to the present day, the farm-buildings of nearly all Ireland, of a large portion of the Scottish Highlands, and of not a few estates in England, and in the Scottish Lowlands, are so miserable and inadequate as to be an insufferable disgrace to both the improved agriculture and the general enlightenment of the age.

The greater number of the farm-houses of Scotland, about a century ago, differed little or nothing in point of comfort from the huts and hovels of cottiers and farm-servants, except in having more apartments; and all the groups of offices, sheds, and yards, for the housing of live-stock and the performance of the home-labours of the farm, were monstrously defective in capacity, in arrangement, and in general position and character. "Some farm-buildings," says the Report of Fifeshire, "were set down at the extreme corner of a farm; some at a distance from water; some were on too small a scale; some badly constructed or arranged; some had no granaries or lofts for holding threshed grain; some had either no sheds, or sheds not sufficiently large for holding the farming implements, which, in consequence of continued exposure to the sun and rain, rapidly decayed; some had no straw-yards; some, no feeding-houses for their cattle,—and, where they had, the stables and cow-houses were, in many cases, too short; some had no proper site for the dung, and the dunghill was sometimes soaking in water, or its rich moisture permitted to run to waste; some wanted a proper milk-house and other conveniences for a dairy; some had no better threshing-floors than damp clay; in short, several accommodations were wanting, which are essential to the prosperity of a farmer."

This picture, though intended to represent only a bygone state of things, exhibits features which are still lamentably and astonishingly common in many parts of both England and Scotland. "No one," said Mr. Grey in 1843, "can have travelled much in the rural districts of England, even in those which are comparatively well-cultivated, without being struck, if he have any sense of neatness and order, with the ill-arranged and patch-work appearance of many of the farm-buildings, which are often placed, in relation to their different parts, in utter defiance of the economy of labour in the case of the cattle, and, what is still worse, with little regard to the production and preservation of the manure, the dry parts of which may be seen exposed to the winds, and the liquid part carried off without being applied to any beneficial purpose. In some, the unnatural practice still prevails of tying up cattle intended to be fattened for the market to stakes, from which they are never released till they are driven off to the butcher; and in another part of the same offices, a younger set of cattle may be found without sufficient shelter and protection to secure their health and comfort. As far as my observation goes, it is not on the estates of the resident country gentlemen, even those of moderate incomes, that the greatest deficiency in good farm-buildings is to be found, but chiefly on the very large estates of the wealthiest landowners,—which may appear rather paradoxical. Is it that they are so little informed on the subject as not to know that such accommodation is necessary to its profitable occupation by their tenants? In such cases, the farm-steads near the residence, or near the roads approaching to it, may obtain some attention; but the remote ones are left to their fate." Multitudes of British farmeries, in fact, continue to exhibit broad traces, and a few absolutely all the features, of the barbarous farmeries of a former age; the great majority, when viewed in the aggregate, are grievously unworthy of the highly improved and rapidly expanding spirit of British agriculture; and entire classes of even the very best display errors in construction or arrangement which will probably astonish the farmers of the next generation. An exceedingly crowded arrangement of the buildings, for example—such as affords only the paltriest scope for shelter-sheds, and the farm-yard feeding of cattle—is so general an error, and obtains such lofty sanction from the absurdly-applied idea of compactness, as to be avoided only on the very large class of breeding and feeding farms in the border counties of England and Scotland.

The farm-buildings of Northumberland and the Lothians, viewed in the aggregate, are superior to those of most other districts of Britain, or, at all events, are equal to those of the best. A large proportion of the farm-buildings of Northumberland, are of quite recent structure, and almost wholly free from the incommodiousness and the patchwork irregularity of their predecessors; and nearly all have a very substantial character, and are built either wholly or chiefly of stone. Some of the older ones are still covered with thatch or with tiles; and a few are covered with grey sandstone flags; but all the recent ones are covered with blue slate from Cumberland or Wales.—Such of the farm-buildings of the Lothians as are older than 25 or 30 years, are, for the most part, low, incommodious, and scattered, and challenge little commendation for either utility of arrangement or beauty of design; but such as have been erected within the last quarter of a century are substantially built, compactly arranged, somewhat neatly designed, ample in accommodation, and conveniently disposed for both the economizing of labour and the shelter of live-stock. The offices have as central a situation as comports with a due regard to other advantages; and, in most instances, they form three sides of a square. The proprietors engage either to repair the old buildings or to erect new ones; and the tenants will not accept mere cottages for themselves, or hovels for their cattle. Nearly all the buildings are substantially constructed of stone; but, in consequence of the dearth of slates and the abundance of tile-clay, the great majority are covered with red-tiles. A considerable portion of the area of each farm-stead is occupied with the feeding-yards and the shelter-sheds of cattle. Each properly appointed yard has along one or more of its sides, a range of shallow troughs, usually three feet above the ground, and composed of either wood or stone, for containing turnips, oil-cake, or other food used by the cattle; and the sheds, in some instances, are surmounted by granaries communicating with the barn. Most of the farmers' dwellings are neat and comfortable houses, varying in size and structure with the extent and character of the farms; and those of recent erection stand at a short distance from the offices, and are accompanied with neat gardens or other small pieces of ornamental ground. The farm-houses of the Lothians, in fact, as well as those of all large farms in other thoroughly improved districts of Britain, are the abodes of gentlemen,—the retreats of both intelligence and taste,—as far different from the hovel-farmeries of former ages as is the light of the nineteenth century from the darkness of the tenth.

But how dismal a contrast to the farmeries of the improved districts of Britain is presented by the huts and the mud-cabins of the enormous majority of the farmers of Ireland! "Nothing," says a brief and decidedly favourable account which Martin Doyle pronounces to be as critically true as it is admirably expressed,—"Nothing, generally speaking, can exceed the wretched meanness of the accommodation afforded even to farmers in otherwise easy circumstances; and the business of cultivation suffers accordingly throughout all its details, from the want of proper conveniences in the offices. But, although the common class of Irish farmers are generally accused of slovenly habits, this part of their want of management is not so much their fault as that of their landlords; it is in fact but a portion of the bad system of tenantry, and the want of capital, which prevail throughout that country. The main object of the landlord is, with very few exceptions, confined to the one point of obtaining the utmost rent for the ground without regard to the character or means of the tenant, or else he lets it on any terms by which he can raise a sum for the supply of his pecuniary necessities. He seldom lays out a shilling upon farm offices of any description; the consequence of which is, that the poor tenant, who holds perhaps only a few acres, cannot afford anything beyond the commonest cottage, with a mud shed adjoining for the shelter of his cow and a pig, or perhaps a stable for his horse, of no better description; and the wealthier order, even of those who hold leases of a considerable quantity of land, being not bound by any conditions regarding expenditure for buildings, nor allowed for repairs, naturally cannot be expected to lay out more money than they can possibly avoid during the existence of the term. There are, no doubt, many instances of superior sets of offices; but they are rarely in the hands of any other than gentlemen of fortune, and the improvements which have occurred in this particular have by no means kept pace with those which have been made in the culture of the soil or the live-stock of the kingdom."

The situation of a farm-stead, whenever a new set of farm-buildings is to be erected, ought to be a point of nice attention and very careful and matured consideration. The old method of grouping several farmeries into hamlets, or of combining them, with huxteries, tradesmen's workshops, and the cottages of farm-servants, into villages, was somewhat justified by the want of domestic security or the dread of foreign invasion in feudal times, but possesses not one element of accommodation to the modern condition of society, and entails a thousand embarrassments upon all the ordinary and most important operations of the farm. The perpetuation of this method among the small farmers of Ireland, is easily accounted for by the low and antiquated state of their agriculture, and involves comparatively little evil from their system of spade husbandry, and of five or six acre farms; but the continuance of it among some of the moderately extensive farmers of Britain, admits not of a word of apology, involves every kind of embarrassment from all the processes of horse husbandry, and ought everywhere and peremptorily to cease. But the placing of the farm-steads of large farms in a corner or on a border of the farms, is in all respects as prejudicial as the grouping of the farm-steads of moderately-sized farms into villages. Part of the land, in every such case, is neglected; too little manure is sent to it; the strength of horses is wasted in draught between the farm-stead and the remote fields; the general expense of cultivation is materially increased; and some of the remote parts are kept in a state of miserable pasturage, or, when occasionally broken up, yield such crops as scarcely defray the heavy costs of draught, tillage, and cultivation. A central situation of the farmery, as compared with an uncentral one, may make a difference of from 1s. to 5s. per acre in the yearly value of the whole farm, according to the farm's extent, and to other local circumstances; and it has been estimated by some intelligent farmers at so much in the aggregate as £100 a-year,—or, on very extensive farms, at the enormous amount of nearly £200.—The farm-steads of farms which have an undulated or a hilly surface, ought not to be situated in a low and moist spot; for, if they be, the crops, however dry and well-conditioned when brought from the field, will soon acquire a softness, and perhaps a mustiness, very injurious to their value, and the health of both the live-stock and the human inhabitants of the farmery will suffer from humidity of atmosphere and the want of ventilation. The heaviest part of cartage upon a farm, too, is the removing of manure from the farm-stead to the fields; and this is seriously greater from farm-steads in low situations than from farm-steads on the same level as the fields, or on a higher level. The site of every farm-stead ought to be dry and well-aired,—either on some summit-ground of an undulating farm, or on some slope or hill-side of a hilly one; yet in bleak districts, it ought to have some such shelter as will afford the whole farmery some protection against the violence of tempests, and as will insure to young stock the degree of warmth which is requisite for their thriving.

Choice of situation is sometimes partially controlled by a due regard to other considerations. The exposure of the farmery, for example, ought to be to the south; for a southern exposure affords shelter from cold north winds, and occasions the cattle of the farm-yard to thrive much better than if they were excluded from the direct play of the sun's rays; and if three-fourths of a farm lie exposed to the north, and only a fourth lie exposed to the south, the site of the farm-stead must probably be chosen within the latter division.—A plentiful and constant supply of good water, also, is essential for the purposes of the dairy, for the drink of the cattle, for the domestic uses of the farmery, and for the daily purification and the habitual cleanliness of the whole farm-stead; and whether this supply be sought in rivulets, in natural fountains, by the sinking of common wells, or by Elkingtonian or Artesian boring, it may, in some cases, require the site of a farm-stead to be selected considerably away from the centre of the farm, and even perhaps in a lower level than that of the great part of the surface. Easy access to general communications with markets and sources of mineral manures, is likewise an object of much importance; and may, in some rare instances, for the sake of avoiding a hill or a deep hollow between the farmery and the public road, require the site of the farm-stead to be selected somewhat away from the centre. "These, however," as Sir John Sinclair remarks, "are only exceptions to the general rule; for it may be laid down as an axiom in agriculture, that the farm-house and offices ought to be placed, as nearly as possible, in the centre of a farm."

The arrangement of the buildings, sheds, and yards of the farmery is to the full as important as the situation; and according as it is good or bad, it elevates or depresses the value of a moderately sized farm to the enormous amount of from £50 to £100 a-year. The great object of arrangement is the facilitating of all home-labours, the promoting of expedition and efficiency in all the work of the offices and yards, or the securing of such a saving of time and labour as will enable tho farmer to conduct the whole of his business with the help of the smallest possible number of servants; and a secondary object—though this, in extreme cases, may, in a pecuniary respect, be considerably the more important object of the two—is to afford the amplest scope and the best appliances for economizing the materials of farm-yard manure, and securing the utmost effects of food upon the health, milk, and carcases of cattle. Many varieties of arrangement may be quite or nearly equal to one another in efficiency; few varieties, if any, are altogether free from some little disadvantages and inconveniences; and varieties somewhat widely different from one another, or even exhibiting some features of absolute contrast, are rendered unavoidable by the different character of farms, the diversities of soils, sites, and relative situation, and the differences of management, tenancy, capital, materials, and taste. In internal arrangement, especially of very extensive suites of farm-buildings, all the apartments cannot possibly be so disposed as to combine desirable convenience with any degree of regularity; and in external arrangement, the architect, in many instances, can do no more than attentively examine the site, and consider all the circumstances, and then use a discretionary judgment in so designing the form and collocation and buildings as best to suit the nature of the farm and the wants of the occupier.

Yet certain pervading principles of both outline and detail, apply to the majority of cases, and are desirable in all. No arrangement can possibly be good which does not permit easy access from the stack-yard to the barn, from the barn to the granary, and from the sheds and offices to the exterior roads, or which has not the straw-house and the turnip store-room in close proximity to the straw-yards, the sheds, and the feeding-houses, or which does not combine these and other requisite facilities of communication with thorough ventilation, proper exposure, and abundant shelter. The circle contains more space within a given extent of enclosure than any other figure, and might therefore seem to be the best outline for the farm-stead; yet it is really the most unsuitable of all figures,—the least adapted for subdivision, and the most expensive in filling up. A rectangular figure, whether square or parallelogram, makes both the most accommodations and the least costly outline; and both the lines of this figure, and those of its subdivisions, when not allowed to be broken by projections, curves, or recessions, comport best with cheapness in the buildings. The most convenient of all general arrangements is to build the offices along the north, the west, and the east sides of a rectangle, to leave the south side open, and to place the farm-house at a convenient and agreeable distance in front.

The area, whatever be the form of the rectangle, and whatever its subdivisional arrangement, ought by all means to be very spacious. "Nothing is more injudicious," said Sir John Sinclair so long ago as 1817, "than to have farm-buildings huddled together, round so small an area as from 60 to 70 feet. Where a farm contains from 300 to 400 acres, the area of the offices should not be less than from 100 to 150 feet square, formed into divisions, that the stock kept may be more equally fed. If it be found expensive to surround the square with buildings, a simple wall may afford shelter, till it is found convenient to enlarge the farm-yard. In fact, none but a practical farmer, who has had a large crop, and a number of cattle maintained during the winter, and who has seen the farm-servants carelessly driving the cattle and carts in confined court-yards, can fully appreciate the advantages of having his offices with a large area." The yards and sheds for the keeping and feeding of cattle may be constructed on very various plans and arrangements, and with very various degrees of capacity; but the best method is to have small sheds, with open yards attached, and to have only one opening in each shed, and this facing the south. The water-courses from the yards, the cow-houses, and the stables to the tanks for the collection of liquid manure, ought to be open causewayed channels rather than underground conduits; and the mode of supplying water to the yards must be controlled by the manner in which the water is obtained, whether from a stream, from wells, or from Artesian borings.

The most advantageous construction of suites of farm-buildings engaged for some time the special attention of the Highland Society, and is very luminously reported on in the 8th volume of their Transactions. Elevations and ground plans of suites for eight different classes of farms are given; and the specifications and estimated costs of each are fully detailed. We shall occupy the sequel of the present article with a digest of the Society's report, and shall thus convey the best information respecting the general construction of the buildings; and we must refer to the report itself for the instructions required in erecting them, and to our own articles, Dairy, Cow-House, Barn, Barn-Management, Ox-Stalls, and Stable, for a view of the proper construction of the chief of the several offices.

All the buildings are described and estimated on the supposition of one set of materials; and when other materials than these are employed, the operations and estimates must be modified to suit them. The corners, ribbets, arches, and skews are supposed to be of hewn-stone; the timber, Memel; the roof-covering, Easdale-slates; the ridges and flanks are supposed to be covered with lead; and, excepting the prime cost of stones, all the materials, as to both cost and workmanship, are included in the estimates. Metal pillars are, in most of the plans, designed for the cart-sheds; but stone-pillars, whenever suitable stones can be cheaply procured, are recommended in preference.

The trenches for the foundations of the buildings are dug at least two feet below the surface. The foundations are formed with flat-bedded stones laid in regular courses, breaking joints alternately, and taken in by regular scarcements. The whole area of the dressing-barn and low granary floors is laid over, to the thickness of 9 inches, with small broken stones; the sleepers are laid on the inside scarcements; and all the remaining space of 14 inches in depth is filled up with solid mason-work of stone and lime properly packed, with a surface coat of plaster three-fourths of an inch thick. The floor of the straw-barn is similarly formed, but with a less depth of masonry, and with a composition-covering of 3 inches in thickness. The foundations of the low buildings are 2¾ feet wide at the bottom, and taken in by regular scarcements. The door-soles of the barns are laid 6 inches, and those of the stables and cow-houses 3 inches, above the surface of the exterior causeway. The walls of the barns are 2¼ feet thick above the door-sole, and 2 feet above the second floor; those of the low buildings are 2 feet thick above the door-sole; and both sets of walls are beam-filled at the top. The division walls of buildings are 18 inches thick, and carried to the top. The foundation of the walls of courts and yards is 2¼ feet wide at the bottom, and at least 12 inches below the level of the general surface. All the external corners of houses and gate-pillars, and all the ribbets, soles and lintels of doors and windows, are droved with broached tails; all the corners and ribbets are at least 2 feet long; the ribbet-heads for barn-windows are 9 inches; the shed-pillars, the arches, and the chimney-tops, are of broached ashlar; the shed-pillars and the gate-pillars are cahmphered or rounded on the corners; the yard-walls are coped with the most suitable stones which can be procured; and the cooling-troughs and feeding-boxes are constructed of pavement. The great common sewer begins in a central part of the offices, and, if a covered one, is 2¼ feet wide and 3½ feet high; and the side-conduits have chisel-jointed angle bottoms, and are from 12 to 18 inches wide and from 18 to 24 inches high, according to their distance from the common sewer. The floor of all the area of the stables, cow-houses, calf-houses, pig-houses, and other similar parts, is formed of whinstone causeway, set in sharp sand; the ducts for the urine have a fall of from 1½ to 2 inches in 10 feet; the ducts of the stables are 10 feet from the wall, and the rise thence to the rack is 5 inches; the ducts of the cow-house are 9 feet from the wall, and the rise thence to the sole-tree is 4 inches; and the floor or surface of the area round the yard is formed either of whinstone causeway or of compact and water-tight macadamizing, with ducts at proper intervals declining 2 inches in every 10 feet to the common-sewer or the side-conduits.

The cupple-sides for houses of 15 or 16 feet wide are 6½ inches at bottom, 5½ inches at top, and 2½ inches thick, with a scantling 6 by 2½ inches, fixed with double garron-nails, and riveted; the cupple-sides for houses 18 feet wide, are 7 inches at bottom and 6 inches at top, with a scantling 6½ by 2½ inches; the cupples are set at 20 inches from centres, on a wall-plate 7 inches by 1½ inch; the sarking is three-fourths of an inch thick, well seasoned and closely jointed,—and that of the granaries is half-checked on the joints; and the ridge-bottoms are 2 inches by 1¼ inch, fixed to the roof with iron spikes, 3 feet apart. The sleepers in the dressing-barn and in the low granary floors are 6 by 2½ inches, and are laid on the inside scarcements at the depth mentioned in the notice of the mason-work; the joisting in the lofts of the unthrashed corn barns and the granaries is 10 inches deep and 2½ inches thick, with 1 foot of wall-hold; both the sleepers and the joisting are laid at 20 inches from centres, and covered with Dram timber batons; the under floors are plain-jointed, and douled with iron douls; and the upper floors are tongued and feathered on the joints, and fixed down with good flooring-sprigs. Cart-sheds with stone-pillars have a joist built into the wall at each pillar, 8 inches by 2½, and the wall-plate nailed down on the top of it; and those with metal pillars, have lintling-beams, 9 inches by 12, and the end of the joist tenanted 2 inches into the lintel, and made fast with an iron strap and screw-bolts.

All the safe-lintels have an inch of thickness for every foot of opening they cover, and are from 9 to 12 inches broad, and have a wall-hold of 9 inches. All the doors are made of deal, not more than 6½ inches broad, 1¼ inch thick, headed on the edges, and grooved and tongued on the joints, with three cross-bars to each, 9 inches broad, 1¼ inch thick, and well nailed,—and all are hung on crooks with bands; the doors of the stable, the cow-house, and the barn, are 3½ feet wide, and may, if necessary, be hung in two leaves; the doors of the granary and the straw-barn are 4 feet wide; the crooks are laid on the bed of the ribbet, have 7 inches hold of the stone, are split in the tail, and have a weight of 3¼ lbs. for the smaller set of doors, and of 4 lbs. for the larger set; the bands are three-eighths of an inch thick at the neck, 2 inches broad, 22 inches long, and 4½ lbs. in weight for the smaller doors, and half-an-inch thick, 2½ inches broad, 23 inches long, and 5¼ lbs. in weight, for the larger ones; the band-nails are counter-sunk and properly riveted; the latches are of the sunk ring kind, and very strong; and the locks are selected in adaptation to the several offices. The frames of the lower windows of barns, stables, and cow-houses, are 2 inches thick, with boards below 16 or 18 inches high, hung on the frames with cross-tailed bands, and glazed above with second crown-glass; those of places where glass is unnecessary, are filled with weather-boards 6 inches broad and 1 inch thick, and hung with iron pivots; and the lower windows of the barn are secured by iron bars 1 inch square, and not more than 5 inches apart, batted into the sole and lintel, and made firm by means of a cross-bar through the middle.

The hind-posts of the trevises are 8½ feet long, 6½ inches square, octagonal above the level of the pavement, sunk 3½ feet below that level, solidly built round 3 feet in diameter with stone and lime mortar; the fore-posts reach 9 inches above the top of the racks, and have their foot set in stones, one on each side of the boards; the trevises are 8 feet long from the wall to the outside of the hind-posts, 4½ feet high at the hind-posts, and 6 feet high at the fore-posts; and the boards of the trevises are 1½ inch thick, mortised 1½ inch into the hind-posts, and nailed to the fore-posts. The racks are 2 feet 10 inches broad, the sides 4 by 2½ inches, the spars 2¼ by 1¼ inches, sunk five-eighths of an inch into the sides, and 3¼ inches apart. The mangers are 20 inches at the top, 16 inches at the bottom, and 10 inches deep, and have a back-lining or skirting on the top where it joins the wall. The under-racks are 2¼ feet high; and the rails are 3 by 2½ inches, and have a rim-beam, rounded on the top, 4 by 3 inches.

A coat of plaster is laid on the walls of the stable for saddle-horses, the front wall of the stables for work-horses, and the walls of the boiling-houses, the dressing-barn, and the granaries; and the plaster is very carefully applied close down to the floors, and close up to the under side of the boards over the joists of the latter two of these sets of offices. Two coats of plaster are laid round the back of the cupples and balks of the saddle-horse stable and the washing-houses; and a ventilator is made in the ceiling of the latter. Three coats of oil paint are given to the outside of all the doors, windows, and gates. The gate-posts are sunk 3 feet into the ground, and burned or charred as far as they go into the ground; the posts are 9 inches square, and champhered on the corners, and set three inches clear of the pillars, and stand 9 inches above the gate, rounded on the top, and built in the ground with stone and lime 4 feet in diameter. The hanging post of the gate is 5 by 4 inches; the front post is 4 by 3 inches; the centre-piece is 3¼ by 2¼ inches; the angle-spar is 1⅜ inch thick, 4½ inches broad at the foot, tapering to 3½ inches at the top. The uppermost spar is of 1¼ inch iron at the end next the hanging post, diminishing to the front post to ¾ inch, and goes through the posts with a shoulder and an eye at the hanging post, and a screw-nut on the end of the front post. The crooks are put into the gate-posts with nuts on the ends. The spars of the gate are 4 inches broad at the hind end, and diminish to 3½ inches at the front, by 1¼ inch thick; the intersections are put together with ⅜ inch screw-bolts.

Five designs of suites of offices and yards, suitable for a farm of 1,000 acres, kept in a rotation of crops and pasture, and employed partly in breeding and partly in feeding stock, are noticed in the Highland Society's Report,—one computed to cost £1,700 with slates or £1,300 with tiles, one £1,600 with slates or £1,230 with tiles, one £1,550 with slates or £1,200 with tiles, one £1,650 with slates or £1,308 with tiles, and one £1,530 with slates or £1,200 with tiles; and a working-plan and elevations of the last of these are given. Two designs for a farm of 500 acres, kept in a rotation of crops and pasture, producing turnips, and employed partly in breeding and partly in feeding stock, are given, and both illustrated with working-plans, the one computed to cost £1,300 with slates or £1,020 with tiles, and the other £1,190 with slates or £940 with tiles. Two designs and working-plans for a farm of 150 acres, of the same description as the preceding, are given, the one computed to cost £600 with slates or £476 with tiles, and the other £550 with slates or £465 with tiles. A design is given, accompanied with a working-plan, for a carse-farm of £500 acres, not producing turnips, and kept chiefly or wholly in tillage, and is computed to cost £1,260 with slates or £1,020 with tiles. A design is given, accompanied with a working plan, for a dairy-farm of 500 acres, kept in a rotation of crops and grass, but with one-half always in hay or pasture, and is computed to cost £1,300 with slates or £1,000 with tiles. Two designs, both accompanied with working-plans, are given for a farm of 200 acres, in the vicinity of a town, wholly in tillage, with no stock but horses and family cows, and with no home-use of any of the main part of its produce; and one of these is computed to cost £600 with slates or £470 with tiles, the other £550 with slates or £400 with tiles. A design, accompanied by a working-plan, is given for a mixed stock-farm in a high country, employing a pair of horses, and is computed to cost £410 with slates or £322 with tiles. Two designs, with accompanying working-plans, are given for a cottage-farm of 25 acres; and the one is computed to cost £190 with slates or £150 with tiles, the other £164 with slates or £130 with tiles.

The farm-house, or abode of the farmer and his family, ought to occupy a convenient site in front of the quadrangle of offices. But for the sake of at once purity of air for the household, the prevention of the risk of communicating fire to the offices by sparks from the chimneys of the house, and of securing neatness, cheerfulness, and decoration to the little home-view of the domicile, the site ought to be selected at a little distance from the offices. A garden or a shrubbery, or a combination of the two with each other, or of either with a small lawn, ought to be attached to the house, and may most advantageously intervene between it and the quadrangle. Though the house ought to be constructed with a rigid and prosaic regard to utility, yet it may easily, and at a cheap cost, be made to possess a little ornament; and it ought both to contribute a feature of neatness to the general landscape of the country, and to convey by its external appearance a notion of the comfortable condition and the gentlemanly status of its occupant. Tastes and judgments differ as to the preferableness of a house with all its apartments and accommodations under one roof, or of a house with wings or other adjuncts; and some persons think that a house of three stories, with the kitchen half-sunk, is the driest, the cheapest, and the most convenient, while others prefer a house of two stories, with the kitchen and its appurtenances in a wing. But several varieties of arrangement may be alike good in different circumstances; and some very wide varieties are made imperative by differences of situation, and especially by differences in the size and character of farms.

A design for an ornamental farm-house, in the rural gothic style, and two stories high, is given in Downing's work, "Cottage Residences." The rural gothic style is preferred, partly on account of the large lofts or garrets, which are afforded by the steep gables and roofs, and which are of so great service in a farm-house, and partly on account of the beauty and picturesqueness which a structure of stone, in even the simplest manner of that style, possesses. The principal floor of the main building measures 46 feet by 30, and is distributed into a hall, a parlour, two bed-rooms, and a large pantry; the second floor of the main building contains three good bed-rooms, closets, presses, and a small bed-room; an ample garret surmounts the second story; the cellar is large, having the same area as the main-building; and the kitchen, the wash-house, each 16 feet square, as well as other requisite apartments, are in an L-form addition, of one story high, in the rear of the main-building. The whole structure is supposed to be of rough stone, or of stone partially smoothed on the face, but not laid in regular courses.—*Sir John Sinclair's Code of Agriculture.—Sir John Sinclair's General Report of Scotland.—Downing's Cottage Residences.—Transactions of the Highland Society.—Communications to the Board of Agriculture.—Journal of the Royal Agricultural Society of England.—Irish Farmer's Journal.—Martin Doyle's Works.—Low's Agriculture.—Loudon's Works.—Stephens' Book of the Farm.—Young's Farmer's Guide.—Hunter's Georgical Essays.—Buel's Farmer's Instructor.—Farmer's Magazine.*

FARMER. The cultivator of a farm. The farmers of Great Britain are either extensive land-owners, who cultivate home-farms or model-farms, on their own estates; or small proprietors, who cultivate each an entire but small piece of land belonging to himself; or yeomen who cultivate farms held on lease from superiors; or cottagers who cultivate small rented farms, either in the form of allotments in the country, or for the sale of dairy produce or of fresh field produce in towns. The third of these classes are by far the most numerous and important in Britain, and are often regarded as constituting the whole body of farmers, to the entire exclusion of the other classes; and they may be subdivided into agriculturists and mere practical farmers, according to the degree of their knowledge, or the scientific character of their practice—and into stock-farmers, dairy-farmers, carse-farmers, and general farmers, or farmers of the mixed husbandry, according to the precise nature of their farms or of their prevailing pursuits. See the articles Agriculturist and Farm.

FARMERY. See Farm-Buildings.

FARM-GATE. See Gate and Farm-Buildings.

FARM-HOUSE. See Farm-Buildings.

FARMING. See General Introduction.

FARM-LABOURERS. All the work-people of farms, whose labour is but occasional, or supplementary to that of the stated labourers or farm-servants. No farmer who carries on an extensive and regular system of operations, can meet the frequent demands of his farm for increased or occasional labour, without either the aid of occasional work-people or a great sacrifice of economy; for most of his stated servants work with horses, so that when they are called to any occasional work, the horses are thrown idle,—and the whole body of his stated servants are, in some important cases, as in that of a rapid ripening of the harvest crops, totally incompetent to meet the urgency of the demand,—and even the least valuable of these servants cost more for some kinds of facile and common-place work than needs to be paid to occasional workers.

One class of farm-labourers are cottiers, and these may be divided into five sub-classes,—such as have a cottage but no land, such as have a right of common, such as have a garden or an allotment-plot, such as have some arable land, and such as have some grass land. This class as a whole are of eminent service to farmers, and rank next in both the frequency and the quality of their work to regular farm-servants; but they differ very widely among themselves in at once worldly condition, general character, and manner of employment. Some are a kind of farmers themselves, and but a degree below the small-farmer yeomen; some hold their cottages by a tenure of independence upon particular farmers, and others by a tenure of entire dependence, and especially of stipulated labour; some spend their whole time profitably and industriously in alternations of labour on their plots and on the farms of their employers; some have a plurality of occupations, but vary widely in the quality, profitableness, and constancy of these; some are, in a considerable degree, systematic idlers; some are but a single grade above the condition of thorough vagabonds; and a large proportion, the steadiest and best conditioned, have not an uniform rule of employment with farmers, but are employed in various ways according to the usages of districts, the peculiarities of farms, or the private interests and inclinations of the parties. The condition of cottier farm-labourers has, for some time past, drawn much attention; and both the importance of it to general husbandry, and the necessity of improving it for the sake of the cottiers themselves, have been increasingly acknowledged. Much information respecting it, and also a full view of the position, interests, and duties of cottiers as independent cultivators of the soil, will be found in our articles ALLOTMENT SYSTEM, COTTAGE, COTTAGE-GARDENING, COTTAGE-HUSBANDRY, COTTAGE-ECONOMY, and SPADE-HUSBANDRY. One of the most interesting and prominent classes of cottiers, a class combining the position of cottiers with that of constant, stated, hired workmen, and constituting the great body of the ploughmen of the south of Scotland and some parts of the north of England, will be noticed in the following article on FARM-SERVANTS.

A large proportion of farm-labourers work by the day or by the piece; and these consist partly of cottiers who are independent of any particular farmers, partly of rural artisans who have not sufficient employment in their proper avocations, partly of itinerant workmen who undertake jobs of particular kinds of work, such as ditching or stocking, and partly of periodical immigrants from poor districts, specially of Irish reapers at the time of harvest. All labourers of this class, with the exception perhaps of mowers and of some of the regular jobbing itinerants, are essentially the same class of men who perform all kinds of drudgery and day-labour in large towns, and are not supposed to possess any other knowledge of farm-work than such as they may have acquired casually or from occasional observation; yet they necessarily differ widely from one another, both in the range and in the value of their qualifications. Great conflict of opinion exists as to the preferableness of employing them by the day or by the piece. A labourer by the day, it is alleged, wastes much of his time in idle talk, and performs much of his work in a make-believe manner, occasions cost and trouble by the necessity of supervision, and has no motive for making a vigorous or energetic use of his strength; while a labourer by the piece works with steadiness and perseverance, has a manly feeling of independence, experiences every inducement to make the best use of his time and strength, executes his work with despatch, occasions no trouble or vexation to his employer, and obtains remuneration proportionate to his industry. But, on the other hand, a labourer by the piece is generally supposed both to hurt himself by doing more work than comports with his health, and to injure his employer by performing all his work in as slim a manner as will possibly consist with the bare maintaining of his credit. Piece-work in the mowing of grass is usually desirable for the sake of expedition in the making of the hay; but piece-work in the corn-harvest, especially in a humid climate or during unsettled or doubtful weather, is usually undesirable on account of the powerful temptations which it offers to cut down portions of the crops in a slovenly or wasteful manner, and in an immature condition of ripeness or of dryness.

Women and children, especially the former, are very extensively employed in some districts, and more or less employed in all, as farm-labourers. The kinds of work which they perform are exceedingly various, and include all light sorts and some heavy ones, not requiring any special training or artistic skill,—particularly the hand-hoeing and hand-weeding of white crops, the singling, topping, and tailing of turnips, the dibbling of wheat, the dropping of beans and pease, the burning of the surface of fen-land, the making of hay, the pulling of turnips, the digging and gathering of potatoes, and the sickle-reaping of white crops. Special commissions under the Poor-Law were sent in 1843 to four sets of agricultural counties in England, comprising Wilts, Dorset, Devon, Somerset, Kent, Surrey, Sussex, Suffolk, Norfolk, Lincoln, Yorkshire, and Northumberland, to inquire into the employment of women and children in agriculture, the sorts of labour at which they are respectively employed, the wages which they receive, their hours of work, and any other similar facts which might tend to throw light on their physical and moral condition,—and to inquire, in a very particular manner, into the employment of children, the ages at which they begin to work, and the effects which their occupation has upon their bodily health, as well as upon their opportunities for obtaining school instruction and moral and religious education. The printed reports form an octavo volume of 378 pages, and possess much interest for at once the farmer, the philanthropist, and the political economist; and though we can afford to give no larger specimen of them than a single sentence respecting Suffolk, Norfolk, and Lincoln, even this may indicate their value. The kinds of labour in these counties, with a single exception, comprise all those which we enumerated; the health of both women and children employed in agricultural labour is good; the work is not all laborious, and is generally preferred by girls of 16 years of age and upwards to hired service; the wages slightly vary in different parts of the same county, but those of women average 8d. a-day in Suffolk and Norfolk, and 10d. a-day in Lincolnshire; the usual hours of work are eight in winter and ten in summer; the morals of the women, particularly of unmarried girls of 16 years old and upwards, seem to be very various, and to a serious extent doubtful or bad; and the children usually begin to be employed in the fields at the age of ten, but, as their employment is not constant, they commonly return to school in the intervals of work. A special class of female day-labourers on farms in the south of Scotland and some parts of the north of England, and ignominiously though most improperly designated bondagers, will be noticed in the following article on FARM-SERVANTS.

FARM-SERVANTS. All the hired work-people of farms, whose labours are stated or constant. The higher classes of them, includin, farm-bailiffs, grieves, foresters, land-stewards under-stewards, and some others, are noticed in our article AGENT. The lower classes are principally apprentices, shepherds, cow-herds, hedgers, and ploughmen.

Apprentices to farmers do not occur in Scotland, and occur only in some parts of England, and chiefly in the western counties. An act of the 43d of Elizabeth makes special provision for farm-apprenticeships, but is not generally appreciated. The young girls of poor parents are, in some instances, apprenticed to farmers, in defiance of their unfitness for some of the hard work imposed upon them, and to the utter ruin of the better prospects which they might enjoy in other positions; but boys are, in many instances, advantageously apprenticed during a term of years for food and clothes and a total sum of from £5 to £10,—and are often found to become farm-servants, and especially ploughmen of both the ablest skill and the steadiest character. The extension of the agricultural apprenticing of boys to every part of Britain, might be followed by highly beneficial effects to the interests both of the operatives themselves and of practical farmers. Lads are boarded with farmers in many parts of the country for premiums, and with the view of being trained to the profession of agriculture; but these are not apprentices, nor in any just sense of the word farm-servants.

Shepherds, in their widest sphere of work, upon extensive hill-farms, are a very responsible class of men; and, even in their limited range, upon farms of mixed husbandry, they require high qualifications, and have a considerable diversity of avocations; and they will therefore be separately noticed. See the article SHEPHERD.—The cow-herd or cattle-man, is generally a man past middle life, and sometimes an old and almost superannuated ploughman. He receives considerably lower wages than a ploughman; yet his work, though light, involves considerable responsibility. Boys sometimes act as mere herds, and are frequently called cow-herds; but they have a more limited charge than cattle-men. The milking of cows is often done by men, but never so well as by women.—Hedgers are of two classes. A superior hedger ranks with a master-ploughman, requires to be a person of considerable intelligence, and has charge of planting, pruning, plashing, and repairing hedges, of pruning orchard and forest trees, and of superintending all the other shrubby and dendritic plants of the farm. An inferior hedger ranks with a subordinate ploughman, or corresponds in both position and employment to a ditcher or a spadesman. Only a farm of large extent, and abounding with hedges and other growths of ligneous plants, employs a superior hedger; and only farms which have no subordinate ploughmen or no day labourers or other occasional labourers to do their work, employ inferior hedgers.

Ploughmen are the staple class of labourers on farms, and will be separately noticed. See the article PLOUGHMAN. A method of employing ploughmen which prevails throughout Northumberland and the best cultivated districts of Scotland, and which assigns to married ploughmen the name of hinds, has been found, by general experience, far superior to other methods. "Farm-servants," says Mr. Grey of Dilston, in a communication in the Royal Agricultural Society's Journal, "are engaged on the large farms in the northern parts of Northumberland, as in the southern counties of Scotland, in a manner very different from that of the same class in the more southern counties of England; and as the custom is little known in many parts, and has evidently a great influence upon the moral and social condition of the labouring classes, as well as being in a great measure essential to the system of turnip-husbandry, which gives so much occupation to females and young people in cleaning the land, gathering and burning couch, and hoeing turnips, I consider it as deserving of particular notice. To conduct the operations of a turnip-farm in summer, and to keep at work an expeditious thrashing-machine in winter, without laying all the ploughs on the farm idle, when many hands are required for untying and carrying forward, to the man at the feeding-board, the sheaves before being thrashed, and for removing and dressing the corn as it comes from the winnowing-machine,—a description of work which women are quite adequate to,—several hands are necessary besides the every-day labourers on the farm. In the absence of villages to supply occasional assistance, as is the case with a large portion of the farms in the district, each one must depend upon its own resources. A necessity is thus created for having a certain disposable force of women and boys at command, which has given rise to the custom of having no ploughmen or labourers living in the farm-houses. Each farm is provided with an adequate number of cottages with gardens attached, and every man who is engaged by the year has one of these cottages; his family, however numerous, commonly find employment, but one he is bound to provide, to answer at all times his master's call, and to work at stipulated wages. To this engagement the odious name of bondage has been given. When the hind has one daughter or more, there can be no hardship, because, when called to work out, which, during the summer months, is pretty constant, she is earning wages; and when she is not so employed, she has the domestic occupation of the family to engage her. In the case of a hind who has no children sufficient for the purpose, there may be hardship in having a servant to hire, provided her services are not required at vacant times in his family. But even then, where is the hardship in the case? If the advantage of the system be not equivalent to the hardship complained of, why does he not abandon it and betake himself to a more independent life, hiring a cottage in a village, and taking his chance for piece work, in the quantity of employment which is to be found in draining, embanking, fences, roads, &c. throughout the country? And why should that be called bondage which is an engagement for a year, terminable by either party at the end of it? The fact is, that the certain employment and the wages of the hind, and his settled condition and abode, give him many advantages over the labourer who has to seek work by the piece or the day in different parts, even when wages are good and work is plentiful; and it invariably happens after a hard winter, when labourers have been laid off work in snow-storms, that many of them seek to be engaged as hinds in the ensuing year." Each hind has, upon the farm, a cottage and small garden, rent free, for himself and his family; and many a hind has also, free of charge, a cow's grass, about one-eighth of an acre of arable land for any crops which he chooses to raise upon it, and liberty to keep a pig and half-a-dozen of hens. Hinds likewise usually receive a small allowance in money per journey, when sent from home with corn, or for coals or lime; and during the time of harvest, they are often maintained entirely by the farmer, in order that they may always be at hand. Several of the members of a hind's family are, in many instances, as statedly in his master's employment as himself; and his own wages are paid chiefly in kind, while those of his sons are paid either in money, or partly in money, and partly in kind, as best suits his convenience. "There are nowhere to be met with," says Sir John Sinclair, "more active, respectable, and conscientious servants, than those who are kept according to this system. There is hardly an instance of their soliciting relief from the public. They rear numerous families, who are trained to industry and knowledge in the operations of agriculture, and whose assistance in weeding the crops, &c., is of considerable service to the farmer. They become attached to the farm, take an interest in its prosperity, and seldom think of removing from it."

FARM-STEWARD. See AGENT.

FARM-YARD. The court or area round or athwart which the farm-buildings of a farmery are situated. Farm-yard is a collective name for the entire group of cattle-yards, shelter-sheds, feeding-sheds, manure-pits, and open areas, situated within the enclosure of the farm-buildings.

FARM-YARD MANURE. The compost of excrement, dead vegetable matter, and other refuse of the farmery, collected in the manure-pits of the farm-yard. It is very generally called muck,—particularly in Scotland and America; and, though exceedingly diversified in composition and power, it is aggregately the best of all fertilizers, both for its chemical action upon the soil, and for the vast range of its adaptations; and in almost all the numberless experimental trials which are made by farmers, gardeners, agricultural chemists, and amateur cultivators, of the comparative powers of the multitudinous manures and composts which are recommended for adoption, it is used as the type of the whole, or as the standard by which they are tested. Many of the topics more or less involved in the subject of farm-yard manure are discussed in separate articles of their own,—the general properties of the animal remains which form its most valuable ingredients, in the article ANIMAL-MANURE,—the solid dung of the several kinds of animals who contribute these remains, in the article EXCREMENT,—the liquid refuse of these animals, in the article URINE,—the classes and properties of bulky foreign matters frequently mixed up with it, in the article COMPOSTS,—the general nature of its dead and decomposing vegetable matter, in the articles GEINE and HUMUS,—the nature and action of the chief chemical products of the decomposition of its animal matters, in the articles AMMONIA and AZOTE,—the kinds and chemical action of its saline ingredients, in the articles ALKALIES, SALTS, and CHLORINE,—some special varieties of itself in use upon the Continent, in the articles AHL and GULLE,—and its general character as a fertilizer, comparatively with that of other manurial substances and composts, in the article MANURE. Our remarks in the present article, therefore, must in some respects be of a quite general nature; and shall be confined to a view of the ancient uses, the composition, the fermentation, the preparation, and the application of farm-yard manure.

The History of Farm-Yard Manure.—Manuring with cattle dung is an exceedingly ancient usage, and has probably been practised in every condition and country of even semi-barbarous agriculture. The effects of animal excrement upon pasture must have been fully observed in the earliest ages of every country in the world, and can scarcely fail to have speedily suggested the propriety of collecting it, and artificially applying it to tillage-land. As soon especially as cattle came to be stall-fed and littered, or to be occasionally shut up within limited enclosures and fed upon cut fodder, the availableness of their manure for fertilizing arable lands must immediately have begun to be understood. An old king, in Homer, is found applying manure to his fields with his own hands. Hercules is said to have published the value of cattle dung as a manure in Italy; and King Augeas is said to have been the first who found out the use of it in Greece. The properties of farm-yard manure, and the collecting of it in dung-heaps, were well-known in the Hebrew Commonwealth, and are alluded to, not only in the Scriptures of the New Testament, but in the very ancient books of

Samuel, Kings, Ezra, Isaiah, Lamentations, and Daniel.

The ancient Romans considered the application of mixed manure to their fields one of the principal operations of agriculture, or second in importance only to ploughing; they carefully sought and collected such substances as were suitable for the purpose; they littered their cattle with straw or stubble; they carefully gathered their cattle's dung, or made a compost of it with the litter; they collected all kinds of ashes; they used different kinds of mineral manures; they burned trees, shrubs, and stubble in their fields; they frequently sowed pulse to be ploughed in as manure while green; and thus they not only appreciated and accumulated such composts as were parallel in character to modern farm-yard manure, but sedulously collected and used all other substances which could make up the deficient supplies of them in the manuring of the land. They were well aware that some kinds of excrements are much more fertilizing than others, and that the same kinds are greatly modified by change in the food of the animals who yield them; they knew well, in particular, the high manurial power of night-soil and the dung of fowls,—and often kept them more or less separate from other manures for the purpose of any special or stimulating fertilization; they displayed much skill in the making of manurial composts, both of kinds strictly analogous to farm-yard manure, and of kinds chiefly mineral, or mixedly mineral and vegetable, or mixedly mineral, vegetable, and animal; they exercised considerable nicety in the manner, and almost in the scientific skill, of making their farm-yard composts; and they generally had two dunghills on every farm, the one for receiving the dung from the offices, and the other for preparing it to be carried to the corn-fields and vineyards. Pliny says, "Dunghills should be made in the open air, in a place which is hollow, and which collects moisture; and they should be covered with straw, that the dung may not be dried in the sun." Varro says, "Near the villa there ought to be two places for dung, or one divided into two parts. Into the one, the new-made dung ought to be carried from the villa; and from the other, the old dung ought to be carried into the field. For that which is but lately brought from the villa is not so good as the other; when it is old and rotten, it is better. The dunghill is the better also, when its sides and top are defended from the sun by twigs and leaves; for it is not proper that the sun should be allowed to exhale the juice which the earth requires. Skilful husbandmen, on this account, let water into the dunghill when it is in their power." Columella says, "There ought to be two places for dung, one for receiving the new dung from the offices, which is preserved in it for a-year; and another for keeping the old dung, which from it is carried to the fields. Both of these, like fish-ponds, should be hollowed with a gentle declivity, and paved in the bottom to prevent the moisture from getting away; for it is of great importance to preserve the sap, that so the dung may preserve its strength, and may be putrefied by continual moisture; so that, if any seeds of briars or grass are thrown into the dunghill along with the straw, they may be destroyed. Skilful husbandmen, therefore, quickly carry off whatever dung is turned out of the sheep-cots and stables, cover it with grates made of twigs, and allow it neither to be dried in the winds, nor withered by the rays of the sun."

The ancient Britons appear to have known the use of both animal manures and mineral manures; and they had sufficient skill in applying them to be able to maintain both orchards and gardens. Yet they originally possessed very crude notions of agricultural operations; and they seem to have acquired a vast increase to their knowledge of manures from the invasion and example of the Romans. The Saxons of England overwhelmed nearly all the agricultural improvements of the Britons, and probably drove manures out of use. The Danish invaders, and the various successive parties during the long period of intestine wars, either repressed the outburst of right agricultural principle, or restrained it within very narrow limits; and some of them passed laws on the subject of manuring which dismally demonstrate to modern times the utterly deplorable condition into which both the arts of agriculture and the rights of property had sunk. One law, for example, provided that a man who manured a piece of land under consent of its owner, was entitled to occupy it and to claim its produce for one year; another, that a man who manured a piece of land with such large quantities of manure as required conveyance by wheeled vehicles, was entitled to occupy it, and to claim its produce during three years; and another, that a man who, under consent of the owner, manured a piece of land by the folding of cattle upon it throughout one year, was entitled to occupy it and to claim its produce during four years. Many of the communities of monks, especially during the century or two immediately preceding the Reformation, brought orchards and gardens into a condition of comparatively high improvement; and may therefore be supposed to have greatly extended the knowledge of the properties and value of farm-yard manure. A celebrated German writer on agriculture, about the middle of the second half of the 16th century, applauds the use of the dung of pigeons and common poultry, but condemns the use of that of ducks and geese; applauds the use of night-soil in mixture with earth, but condemns the use of it in an unmixed state; pronounces the dung of asses superior to that of sheep, the dung of sheep superior to that of goats, the dung of goats superior to that of cattle, the dung of cattle superior to that of horses, and the dung of horses superior to that of swine; recommends the use of grass-clods, heath-turfs, and the rubbish of thickets, both as a manure-litter for sheep and as good material for making manurial composts with animal excrements; and promulgates some other notions which serve the purpose of showing both that many varieties of farm-yard manure were in use, and that the relative value of the ingredients which composed them, as well as the general character of the whole, was very imperfectly understood.

The advancement of the knowledge of farm-yard manure, in its composition, its preparation, its chemical changes, its varieties of character, its powers of fertilization for different crops, its value ralatively to that of many special manures, and the methods and seasons of its application to the soil, has been very great in modern times and in all departments of agricultural research, but especially within the last few years, and in the departments of farm-yard manipulation, field experiment, and chemical analysis. Practical men of several classes, farm-architects, farmers themselves, the workmen of farmers, and agricultural chemists, have made common stock of their skill to devise the methods of gathering, keeping, and preparing farm-yard manure which shall invest it with a maximum of fertilizing power; scientific agriculturists of all classes have brought both argument and experiment to bear, a thousand times over, upon the intricate and important question of the fermentation of the manure; practical and enterprizing farmers have made countless comparative trials of the manure, in different conditions, in different combinations, and in different methods of preparation and application, upon the several kinds of crops; and agricultural chemists have made searching and multitudinous analyses both of entire specimens of the manure and of each of the several ingredients of which it is usually composed, and have also plunged into profound investigations respecting the modes of action of its fermenting masses within the soil, and of its ultimately decomposed and recombined principles upon the plants of the several agricultural crops. Yet the results of all this multiplicity and magnificence of effort are, for the present, rather bewildering than instructive. A few grand rules, indeed, have been completely established; but most of these were previously understood and appreciated by all the better or more enlightened class of farmers; and the great majority of the conclusions arrived at are either too doubtful, too theoretic, or too sublimated to be capable as yet of any useful application to practice. "On the subject of manure," remarked Mr. Pusey in 1842, "it may be said that we have learnt a great deal in the last four years, but know nothing; for we have learnt many of the chemical principles on which manures act, but we do not yet know how to apply those principles to the daily working of the farm." All the principles of agricultural chemistry, in fact, great, mighty, and multitudinous though these principles are, may be said to concentrate themselves in the one topic of farm-yard manure; and the very number, and importance, and intricacy, and progressive development of these principles evince both the difficulty, in the present state of things, of practically understanding that topic, and the necessity for years to come of subjecting it to skilful, persevering, and manifold investigation.

The Modes of Collecting Farm-Yard Manure.—The collecting of farm-yard manure on cottier farmeries or on other very small farmeries, is a process so simple and routine as to admit of little variation; but it is very generally performed under conditions of exposure to the weather, and of indifference to the loss of liquid matter, which enormously decrease the manure's bulk, and rob it of probably one-half its value; and it ought, in every instance, to be so far amended that, whether variety in adaptation to different kinds of crops can be produced in its character or not, at least its substance may not be wasted, and its general power may not be impaired. But the collecting of farm-yard manure on large and well-conducted farmeries, varies in method with the nature of the farm, the arrangement of the farm-offices, the particular manner of feeding, and even the season of the year.

When the number of cattle kept is a multitude compared to the horses, as on both dairy-farms and cattle-feeding farms, the aggregate manure has necessarily a vast preponderance of cattle dung in its animal constituents, and is comparatively very poor in nitrogen; but when the number of horses kept is quite or nearly equal to the number of cattle, as on carse-farms, the aggregate manure takes its characteristic quality from the presence of horse dung, and is comparatively rich in nitrogen; and in either of these cases, little scope is afforded for assorting the manure into heaps of different qualities, and with distinctive adaptations to different kinds of crops. But when the live-stock of a farm is at once large, various, and mutually well-balanced, when it comprises large proportions of horses, cattle, swine, and poultry, and when the farm-buildings are arranged in several quadrangles or large subdivisions, ample opportunity exists for amassing perfectly distinct sets of farm-yard manure, variously proportioned to each other in their wealth of nitrogen and salts, and possessing such widely different powers and adaptations as shall give the farmer a specific remedy for the particular kind of exhaustion of each separate field, and enable him to make a practical and highly profitable application of the doctrines of agricultural chemistry;—and this range of distinct accumulations, too, may be considerably modified or materially extended by the regular intermixation of foreign matters with the manure, so as to produce one or more manurial composts of the nature either of dilutions of the farm-yard manure, or of addition of elements to its character. See the article COMPOST.

When all the animals who yield the excremental portion of the manure are fed in the house, and when either they are few in number or the farm-yard has no subdivisions, the usual practice is to accumulate dung, litter, and all other refuse in one carried and indiscriminate heap, in nearly the same manner as cottier farmeries; and the modes of this practice, in multitudes of instances, have quite as much need of reform as those of cottier accumulations,—and might, in not a few instances, be easily so modified as to secure some of the advantages of methodized and classified accumulation in the largest and best kinds of farmeries. In all good feeding-farms, cattle are kept wholly within the farm-yard during the winter half of the year, and are there fed either in houses, in shelter-sheds, or in open subdivisions of the yard upon different kinds of roots and fodder and mixed food; and though the methods of feeding them, as to both place and aliment, are diversified, the modes of accumulating their manure are only two,—either to carry it out daily to dung-pits when they are fed in the house, or to let it lie and amass beneath them till the end of the season, when they are fed in sheds and in open subdivisions of the yard. In the former case, it of course is a daily upturned mixture of fresh litter and newly dropped excrement; and in the latter case, it is a continuous accumulation of successive layers of litter and excrement trampled and sodden into thorough intermixture by the constant tread of the cattle.

A most important consideration for determining both the method of collecting farm-yard manure and the circumstances under which it is collected, is to prevent the escape of ammonia. Not only is the nitrogen of manure the most important element for elaborating those proximate principles of plants which form the best or characteristic food of animals, but it constitutes the fermentative virus of the whole mass of the manure, and is the power on which the solubility and digestion of both its animal and its vegetable ingredients depend. Now this nitrogen, almost as soon as animal excrements are dropped, begins to rush into combination with hydrogen, and to form ammonia or the volatile alkali,—that pungent-smelling gas which rises invisibly, rapidly, and with such sensible effect upon the nostrils from the recent dung and urine of all animals, and particularly of horses and fowls; and so large a quantity of ammonia as two and a half pounds is formed from every pound of nitrogen; and when this is not arrested in the very process of its evolution, and fixed into some combination which holds it fast in the form of salt, and prevents it from assuming its proper aeriform condition, it escapes into the atmosphere, and carries irretrievably away all the best virtues of the manure. Some facile and important chemical means of fixing it are noticed in our separate discussion of its properties; and ought to be fully considered by every farmer in reference to his method of accumulating farm-yard manure. See the article AMMONIA. One easy methodical means of at least partially fixing ammonia, so as to retain much of it which would otherwise escape, is to promote the speedy decay of the litter by immediate, continuous, and thorough intermixation with the excrements; and an obvious application of this means is to accumulate as large a proportion of the manure as possible in the manner of constant amassing and treading beneath the cattle in the yards. Another methodical means, much in use on the Continent, and recently a good deal urged on the attention of British farmers, is more doubtful. This consists in collecting separately the liquid excrements of cattle, and the liquid emanations from the dunghill; and it has arisen from three considerations,—one, the want of sufficient litter to act as a sponge in detaining the liquid,—another, the supposed desirableness of applying a top-dressing of liquid manure, such light sandy lands as those of Belgium and Holland, to spring corn, carrots sown among beans, and some similar crops, —and another, the well-known fact, that, in the case of almost all domestic animals, but very particularly in the case of horses, urine contains a far larger proportion of nitrogen than is contained in the solid excrement. But whether the urine be run into collecting tanks immediately from the urine ducts of the farm offices, or whether a dilution of it be allowed to form with rain and snow, and drawn off through the dungpit in the form of a general liquid refuse to a common collecting-pond or great tank at a little distance, its loss of ammoniacal matter, in almost all ordinary cases, is exceedingly great. "Whoever," says Dr. Sprengel, "is obliged for want of straw to collect the urine separately,—whoever, if he be compelled to do this, mixes no water with it, or fails to employ some neutralizing substance to combine with the ammonia which is produced in so great a degree during the summer,—suffers a loss of manure which exceeds all belief." Artificial dilution with water, too, is of little avail unless the proportion of water be so great as to occasion excessive trouble and cost in carrying the liquid manure to the fields; and natural dilution with rain sometimes takes place in such enormous quantity as to reduce the proportion of salts to two per cent., and to render the liquid manure not worth the trouble of carriage.

Yet the flow of some liquid from the farmyard, and the evaporation of a considerable portion of the dung and urine of cattle, are unavoidable; and some of the fixed ammonia necessarily dissolves and passes away with the liquid, while some of the unfixed ammonia volatilizes and passes away with the vapour. "One remedy," remarks Mr. Pusey, "is to prevent the rain from flowing down the surrounding roofs into the yard, by placing gutters under the eaves. Perhaps another would be what I have seen in an old-fashioned yard, a hollow space like the basin of a dry pond, three or four feet deep, with a drain near the top that prevents it from overflowing. This hollow I was about to do away with as unsightly; but when filled as it now is with couch-grass—leaves or stubble would certainly have a better appearance—it seems likely to answer the purpose of detaining valuable salts that would otherwise run away. After all, if the yard be well littered, and the dunghills be covered with earth, I doubt whether, excepting on grass farms where the tank may be necessary from the want of straw, the present management of dung can be greatly improved, though in many districts the quality certainly may." Yet even these remarks—though preceded also with the expression of a doubt whether the alarm on the subject of the loss of manure from the farm-yard be not somewhat exaggerated—distinctly imply that all the dung and the urine should be protected from the action of the weather, and reduced with all possible speed into an incorporated mass with absorbent decomposing vegetable matter, and that, though well enough managed in the existing practices of the best large farms of the mixed husbandry, they are capable of being treated with some chemical appliance which shall fix the whole of the ammonia, and produce a corresponding increase in the "quality" or fertilizing power of the compound manure.

Another important consideration in the methods and circumstances of accumulating farm-yard manure, is to prevent the commencement of fermentation previous to the near approach of the time when the manure shall be deposited in the soil; and this consideration, happily, is well provided for by some of the ordinary appliances and modes of treatment which prevent the dissipation of ammonia by vaporizing action, and the waste of the general substance of the manure by the action of the weather. The great points are the averting of extraneous moisture, the maintaining of a cool interior temperature, the preventing of the permeation of air, and the absorbing of all liquid matter by bibulous vegetable substances. The ordinary arrangements of all well-constructed farm-yards more or less secure these points; and on farmeries on which stall-feeding is practised to the exclusion of feeding in yards, some such arrangements and methods as the following may, in some degree, combine the advantages and diminish the disadvantages of both accumulation in the manner of house-feeding, and accumulation in the manner of yard-feeding:—"A shed must be formed on either side of the cow-houses and stables, as found most convenient, from 12 to 15 feet wide, by means of light rafters, and the other extremities on a plate placed on a range of posts at the distance above-mentioned from the wall. This shed may be subdivided into three equal compartments by common draw-rails; and there should be an opening in the wall opposite to each of these divisions, in order conveniently to throw the dung and litter into the shades, as also smaller apertures for the urine to pass. The stock should be occasionally penned in one or more of the spaces in the shed, according to the quantity of the materials and number of animals, for the purpose of trampling and consolidating them; and this operation must be commenced with the first removal of dung and litter. The floor of the shed may be of any firm retentive material, sloping from each side to the centre. There should be a well to receive what moisture may sink from the materials, by means of a gutter the whole length of the shed; and the liquid so received must be there, or in some other commodious place, mixed with moss or mould, so as to bring it to a consistency that will prevent fermentative action until the period for general fermentation, when this may be incorporated with what had been prepared in the shed, or otherwise reduced to a more fit or less pungent state by an admixture of such matter as may be found best adapted for the land to which it is to be applied. When a certain quantity of materials shall be collected in the shed, these may be forked out and placed on a dry site, with a layer of moss or mould in the bottom to absorb the liquid; the heap to be made in a compact form, compressed, and rounded on the upper surface. Moss or mould should be put into the bottom of the shed, and this placed on the upper part of the heap when removed, with clay, marl, or turf on the upper surface of the whole, and rounded and beat down so as to exclude air and moisture from the interior. This operation of removing and covering up the materials may be performed monthly, or more frequently if thought advisable, and, if possible, in dry and cold weather."

The Composition of Farm-Yard Manure.—The chemical composition of farm-yard manure, or the aggregate power of its proximate principles to fertilize the soil, is, as already hinted, exceedingly various. Three chief causes of this diversity, partly inclusive and partly irrespective of numerous subordinate ones, are in operation,—the number and kinds of gross materials in the dung-heap, the proportions in which the more nitrogenous of these are combined with the less nitrogenous, and the exceedingly contingent and variable character of each kind of excremental ingredient, as affected either by the food and condition of the animal yielding it, or by the circumstances under which it is collected and accumulated with the other ingredients of the compound manure.

The diversity of the gross materials of farm-yard manure is so well-known as scarcely to require illustration; for, in a cottier farmery, it comprises ashes, sweepings, weedings, all sorts of refuse from house and offices, and all kinds of gatherings from the roads and fields; in multitudes of farms with poor manurial resources, it comprises an enormous intermixture of many kinds of foreign matters, both vegetable and mineral; in some farms of all classes, it comprises some proportion of blood, offals, carcases, and other highly nitrogenous putrescent substances; in farms in the vicinity of towns, of fisheries, of tanneries, or of other sources of peculiar refuse, it comprises a large proportion of either very poor or very rich matters, of a description which occur either not at all or in exceedingly small quantity on farms of other classes; in stock farms and dairy farms, it comprises a preponderance of a vastly poorer kind of excrement than in carse farms or farms of the mixed husbandry; and even in farms of the highest class of strictly kindred character, and affording the amplest scope for giving it a normal and an uniform character, it often, as we saw before, is purposely amassed in heaps of widely different qualities, and always is subject to a greater or less degree of unintentional variation.

Even though farm-yard manure were examined only as it occurs on first-rate farms and under the best management,—though it were viewed as consisting only of litter and of animal excrement, and as accumulated and preserved in circumstances the most conducive to its strength and richness,—it would still disclose to chemical analysis a diversity of composition so great as to astonish and almost confound ill-informed farmers. The manure of cattle fed in the straw-yard is vastly poorer than that of cattle fed on turnips; the manure of cattle fed on turnips is vastly poorer than that of cattle fed on oil-cake; the manure of horses fed on straw and hay is incomparably poorer than that of horses fed on corn; the manure of pigs fed in any ordinary manner when they are lean, cannot bear comparison with that of pigs fed in a fattening manner when they are in high condition; the compound manure which has a preponderance of cattle excrement is less powerful than that which has a preponderance of horse excrement; the compound manure which contains no night-soil, is much less powerful than a compound manure of precisely the same kind which contains a proportion of night-soil; the compound manure which contains merely a sufficiency of vegetable matter for reducing its animal matter, is far more powerful than such as contains a great excess of vegetable matter; and the compound manure which has been carefully and wisely accumulated, is vastly more powerful than compound manure of precisely the same kind which has had much of its ammonia dissipated, and has been allowed to undergo premature fermentation. Some other broad varieties in the composition of the animal ingredients of farm-yard manure, are noticed in the articles Animal Manures, Excrement, and Urine.

An analysis of any one specimen of farm-yard manure, then, would afford no view whatever of the chemical constitution of farm-yard manure in general, and could not assist the judgment to form a near estimate of the constitution of widely different specimens. An average specimen of the farm-yard manure of Bechelbronn was found by Payen and Boussingault to contain in its wet state 0·41 per cent. of nitrogen, and in its dry state 1·95 per cent.; and a specimen of manure from an inn-yard was found by them to contain in its wet state 0·79 per cent. of nitrogen, and in its dry state 2·08 per cent. But the difference in value between these two specimens serves only to indicate the vastly wider differences which must subsist among many ordinary specimens,—between, for example, the straw-yard manure of a mere cattle department and the stable manure of corn-fed horses, or between the ashy, washen, mineral-looking dung-heap of an ill-conditioned cottage-farm and the rich, soapy, mellow "muck" of the fat cattle and well-fed horses of a well-managed, large, mixed farm. The only satisfactory method of estimating the comparative power of any one mass of farm-yard manure, short of an actual individual analysis of it, is to observe the kinds of animal excrement which it contains, and the proportions in which these are combined with one another and with the vegetable matters, and then to found a calculation upon the several and separate analyses which we have given in the articles Excrement and Urine. Yet a succinct popular view of the general composition of stable manure, and of its action within the soil or upon vegetation, may here be advantageously given, if not to assist a farmer to estimate the comparative value of any particular specimen of manure, at least to enable him at one glance to identify the principal doctrines of agricultural chemistry with the whole subject of farm-yard manure.

Now stable manure supplies plants with all the food they require, additional to what they obtain from the air; and it consists proximately of water, humus, and salts, and remotely of oxygen, hydrogen, nitrogen, carbon, sulphur, phosphorus, chlorine, potash, soda, lime, magnesia, alumina, iron, manganese, and silica. These fifteen remote substances constitute by their mutual combinations the proximate substances water, humus, and salts; and they are distributable into four classes,—first, the gaseous, comprising oxygen, hydrogen, nitrogen, and chlorine,—second, the combustible, comprising carbon, sulphur, and phosphorus,—third, the alkaline, comprising potash and soda,—and fourth, the earthy and metallic, comprising lime, magnesia, alumina, silica, iron, and manganese. The ingredient ammonia, which plays so conspicuous a part in everything connected with the accumulations of the farm-yard, and which has been described as "the heart of manure, keeping up the healthy circulation among the other members," is a combination of nitrogen and hydrogen, constantly and facilely in the course of formation till the whole of the nitrogen is exhausted; and common culinary salt, which is a valuable ingredient in manure, is a combination of chlorine with the base of soda, and may be regarded as representing all the chlorine of the mass, just as ammonia, in ordinary circumstances or in those in which nitre is not formed, represents all the nitrogen. The salts of manure are combinations of certain acids with the alkalies, the earths, and the metals; and the acids belonging to them, or concerned in their formation, are previous combinations of oxygen with the carbon, the sulphur, the phosphorus, and the silica. Some of the salts are volatile or caustic, and act quickly in the manure; and some are fixed or emollient, and act comparatively slowly. The mould formed by the decay of vegetable matter, or of the plants or parts of plants raised in agriculture, consists, like the whole mass of farm-yard manure,—though in widely different proportions, and sometimes with little or no traces of some of the remote constituents,—of water, humus, and salts; and part of this mould is dissolvable and made fit for the absorption of plants by the action of water, while the remainder is dissolvable and made fit for assimilation by the action of the alkalies.

The water of farm-yard manure has precisely the same action within the soil and upon plants as any other water; and, viewed apart from matters held in solution, consists wholly of oxygen and hydrogen. The vegetable part or forming mould of the excrementitious portion of the manure, is more or less soaked with the bile, the mucus, and the other liquid secretions of the digestive and intestinal systems of the animals which have yielded it; and even the forming mould of the litter is greatly affected in both mechanical and chemical character by its contact with the excreted vegetable matter, and by the action upon it of the feet and the urine of the cattle; and the compound mass which comprises these two sets of forming moulds, in consequence, undergoes a far more rapid decay than fresh hay or any mere vegetable compound, sends off a large portion of its substance in the gaseous forms of watery vapour, carbonic acid, and ammonia, and generates and maintains a heat closely akin in both nature and results to a slow smouldering fire. Now the evolution of the carbonic acid, the evolution of the ammonia, and the generation of the heat, all play a powerful part in the intricate process of fertilization. The carbonic acid divides and reduces the earthy constituents of the soil, and thus produces the same effects upon them as the combined action of air, rain, and frost; and it also eliminates from them their potash and other alkalies, and contributes its carbon to the nourishing of young plants up to the time of their exfoliation, and thus both extracts saline food for the plants out of the soil, and assists to rear them up to the condition in which they become able to feed themselves with carbonaceous matter from the atmosphere. The ammonia acts as the chief solvent power in the digestion of the food of plants within the soil; it exerts a force upon the store of crude nutrient matter for plants analogous to that which a pair of bellows exerts upon ignited fuel in a grate, kindling up and accelerating the combustion of the slow smouldering fire; it expends its alkalinity in the same efficient direction as potash and soda; it combines with free acids, or with an acid evolved out of the decaying manure itself, to form a powerfully acting salt, closely akin in nature to saltpetre; and it surrenders its nitrogen to the secretion or constitutional formation within the seeds, the roots, and the other esculent parts of plants, of those azotised proximate principles which render them proper or nourishing food for animals. The heat assists the germination of seeds, corrects the bad properties of cold and churlish soils, accelerates the decomposition of the crude or proximate principles of both soil and manure, and stimulates such chemical affinities as force the liberated elements of these principles into the new combinations requisite to the growth and strength of vegetation; but this heat may either be so low as to want sufficient power for the performing of its offices, or so excessive as to produce actual combustion and enormous waste and damage; and happily, it is completely under the control of the parties who collect and prepare the manure, and can be abundantly regulated, as to the degree in which it shall be developed, both by the proportioning of the most nitrogenous kinds of excrement, and by the methods practised for excluding or admitting the free permeation of the air. The salts in farm-yard manure are both somewhat numerous in themselves, and quite multitudinous in their modes of action upon fertilization and vegetation; so that we could not, without a very long digression, make any satisfactory mention of them here, and must refer, for a view of them, to our articles Alkalies, Alumina, Chlorine, Phosphates, Silicates, Sulphates, Salts, Soda, Potash, and Agricultural Chemistry.

The Fermentation of Farm-Yard Manure.—The process of fermentation co-exists with some of the many actions of the constituents of farm-yard manure, and is a necessary preparation or introduction to others. Chemical change, of some kind or other, whether eremacausis, saccharine fermentation, or some other mutual play of affinities, is always taking place upon all vegetable and animal substances which lie open to the weather; and this change, in the case of such a compound of dead vegetable and animal matters as farm-yard manure, tends rapidly to take the character of both the acetous and the putrefactive fermentation. The process of fermentation, in fact, is precisely that which generates the heat of the manure, sets free the elements which combine and escape as gases, and reduces the finally solid principles to such a state of solution as renders them absorbable by the spongioles of plants. The vegetable and animal substances of the manure which contribute any of their elements to the nutrition of plants, require to be decomposed by fermentation, in order to allow these elements to be released and to enter into absorbable compounds; and the mineral or saline matters, being incapable of assuming the gaseous form within the soil, and yet requiring to be taken up into the interior of the plants, must be reduced to a state of solution in water, or at least to a state of impalpable comminution in order to their being absorbed by the spongioles. But in consequence of fermentation acting in all the three capacities of a preparative for some of the fertilizing actions of manure, a dissipator of some of the most valuable elements of manure, and a generator of the heat which constitutes one of the great powers of manure, a vast difficulty is encountered of so harmonizing these capacities as to bring out a maximum of their fertilizing results; for if the preparational action of fermentation be mainly looked to, the major part of the substance of the manure will be lost by dissipation, and nearly all the beneficial effects of the eliminated heat will be uselessly squandered by anticipation; while if the conservation of the substance and the reservation of the heat till the season of application to the soil be mainly looked to, the preparational action is so much repressed as to occasion a large proportion of the alimentary principles of the manure to be presented to the spongioles in too crude a state for their absorption. "That which makes the preparation of manures in the most profitable manner a subject of no little difficulty," remarks M. Le Compte Chaptal, "is, that whatever method we adopt, there will still be a loss of some portion of their nutritive principles. Even when manure and litter are carried to the fields in an entirely fresh and unfermented state, and mixed immediately with the soil, although, by this means, the salts and soluble juices are all preserved to be converted to the uses of vegetation, still the fibre, the unctuous matter, the oils, &c., remain in a great measure inert in the soil, and their subsequent decomposition will be very slow and imperfect. If, again, in reverse of this, the manure be collected in heaps in the farm-yard, it speedily becomes heated, carbonic acid gas, and then successively carburetted hydrogen, ammonia," sulphuretted hydrogen, phosphuretted hydrogen, and some other gaseous compounds, "in great quantities are evolved, and these substances are entirely lost in vegetation; a brown liquid, the colour of which becomes more and more dark, moistens the mass, and flows upon the ground about it; every portion is gradually disorganized; and when at length the fermentation is complete, there is left only a residue consisting of earthy and saline matter, mixed with a small quantity of blackened fibre and charcoal in the state of powder."

Farm-yard manure either quite fresh or very slightly fermented, so as to retain its litter in an undecomposed and but partially broken state, has long been called by farmers long dung; and farm-yard manure either so thoroughly fermented and rotten as to be a powdery or saponaceous mass, or so free from intermixture of litter as to consist almost wholly of a compost of solid excrements, has long been called short dung; and much controversy, often sharp and always unmeaning, has been carried on by practical men, unacquainted with the principles of agricultural chemistry, as to whether long dung or short dung is the best,—and this controversy has received from some otherwise well-informed agricultural writers the sage decision, that short dung is the best for securing a single great crop, and long dung is the best for prolonged action or for a series of two or more crops. But short dung, especially when understood in the sense of thoroughly rotted compound manure, is simply a portion of the mass in a state of high preparation for the immediate feeding of plants, after other and bulkier portions of the mass have been lost by gaseous dissipation; and the employment of it by gardeners or any other parties who desire a rapid and concentrated manurial action, is simply the procuring of that action at the twofold expense of losing all the manure which has been dissipated in the fermentative process, and of foregoing the advantages upon future year's crops which would have accrued from using the manure in its fresh or but slightly fermented condition. The use of "short dung" is thus, in a general view, both an enormous waste of manurial matter and a great abbreviation of manurial duration, for the sake of obtaining one season's special rapidity and power of manurial action. Yet a modified or limited use of "short dung," as in most of the processes of the flower-garden, and in many of the finer processes of the kitchen-garden, may frequently be such as to justify its sacrifice of economy; and the employment of farm-yard manure in various stages of fermentation, intermediate between the conditions of "long dung" and "short dung," is sometimes demanded by a judicious and even by an economical regard to the peculiar habits of some particular crops. "In practice," remarks Professor Low, "our object is to produce certain kinds of crops; and certain kinds of plants, it is found, require a greater action of manures at particular stages of their growth than others. Thus, the turnip, the carrot, and the beet, which are sown in the early part of summer, require that the manure applied shall be in such a state of decomposition as to act upon and nourish them in the first stages of their growth; and if this be not so, the crop may entirely fail. In these and similar cases, accordingly, a complete preparation of the farm-yard dung is an essential point of practice. Certain plants, again, do not require the same state of decomposition of the dung. Thus the potato requires less in the first stages of its growth than the turnip; and hence it is not necessary to subject the manure to be applied to the same degree of fermentation."

But the general rule, now well established by science, by experiment, and by appeals to economy,—and made all the more firm by the fact, that bone-dust, guano, and other special manures are available for turnips and for all other cases requiring rapid or concentrated manurial action,—is that farm-yard manure ought to be applied to the land in as fresh or slightly fermented a condition as comports with the destruction of the grubs, the larvæ, the ovules of insects, and the seeds of weeds which it may contain. An experiment demonstrative of this rule was long ago made by Sir Humphrey Davy, and has since been frequently repeated by other agricultural chemists. "I filled a large retort," says Sir Humphrey, "capable of containing three pints of water, with some hot fermenting manure, consisting principally of the litter and dung of cattle; I adapted a small receiver to the retort, and connected the whole with a mercurial pneumatic apparatus, so as to collect the condensible and elastic fluids which might arise from the dung. The receiver soon became lined with dew, and drops began, in a few hours, to trickle down the sides of it. Elastic fluid likewise was generated; in three days thirty-five cubical inches had been formed, which, when analysed, were found to contain twenty-one cubical inches of carbonic acid; the remainder was hydrocarbonate, mixed with some azote, probably no more than existed in the common air in the receiver. The fluid matter collected in the receiver at the same time amounted to nearly half-an-ounce. It had a saline taste, and a disagreeable smell, and contained some acetate and carbonate of ammonia. Finding such products given off from fermenting litter, I introduced the beak of another retort, filled with similar dung very hot at the time, in the soil amongst the roots of some grass in the border of a garden; in less than a week, a very remarkable effect was produced on the grass; upon the spot exposed to the influence of the matter disengaged in fermentation, it grew with much more luxuriance than the grass in any other part of the garden." It thus appears from this experiment, and still more fully from the principles which we stated respecting the composition of farm-yard manure and the modes of its action in fertilization, that the very matters disengaged during the process of fermentation are precisely those which contribute to the growth and substance of plants; so that any degree of fermentation which takes place before the manure is deposited in the soil, and made to act upon the crops, is exactly so much clear loss to vegetation. Many farmers, however, have contended that the litter of the manure must be so far reduced by fermentation as to be capable of lying close to the seeds and rootlets of the crop, and that the whole mass of the manure must be so far fermented as to destroy the germs of noxious weeds and insects. But though soil requires to lie close to germinating seeds and growing rootlets, manure rather injures than benefits them by lying close, and best serves its purpose when merely so near as to surrender its disengaged elements to them in the form of gas or of watery solution. The destruction of the germs of weeds and insects, indeed, whenever the litter of the manure has been reaped from the fields in a somewhat foul condition, is indispensable, and in even the most favourable circumstances is desirable; and therefore up to the point of effecting this destruction, but certainly not a hair's-breadth further, ought fermentation to be carried. Some scientific and very judicious farmers adjudge fermentation to be at the proper point when the long culms of straw which formerly matted the manure into cohesion are so far decomposed as to allow the parts of the manure to be readily separated by a fork; but those have a more scientific practice, and effect a considerably greater economy of the fertilizing principles, and at the same time quite as effectually secure the destruction of noxious seeds and larvæ, who either know how to recognise the transition from the vinous fermentation to the acetous fermentation, or first ascertain from general observations how slight a degree of chemical change destroys the vitality of any of the ordinary seeds of agricultural plants, and how trivial an amount of decomposition or even of discoloration this degree of change effects upon straw, and then adjudge any mass of farm-yard manure to be sufficiently fermented when that trivial amount of decomposition, or the transition from the vinous to the acetous fermentation, has taken place. The loss of ammonia, carburetted hydrogen, carbonic acid, and other fertilizing gases, from bad methods of collecting farm-yard manure on the farmeries of ignorant cultivators, forms an enormous and almost incredible daily aggregate throughout the kingdom; and the loss of the same substances, at a stage of greater value or at more advanced periods of the season, from processes of excessive fermentation on the farm-steads and the field-borders of well-informed but injudicious cultivators, forms an aggregate, if not so wildly wasteful as the former, at least astonishingly great in itself, and not a little discreditable to the present advanced condition of agricultural knowledge and scientific husbandry.

The fermentation of farm-yard manure preparatory to its being deposited in the soil, whether the process be carried only to the slight degree which we contend for as the most economical, or whether conducted onward to any of the points of "shortening the dung," ought to be done uniformly, steadily, and in a single operation. The piecemeal methods of collecting and preparing farm-yard manure which are practised by multitudes of farmers,—methods which induce a series of incipient fermentations, which disturb and perhaps arrest each incipient process, and which subject a large portion of the manure to alternations of conflicting forces,—are both utterly absurd in principle, and exceedingly wasteful in practice. "Whether farm-yard manure," remarks a writer in the Quarterly Journal of Agriculture, "be brought to the consistency only of what the farmer terms long dung, or his operations be carried much farther, it is certain that these should be conducted on chemical principles, and assimilated to the operations and rules which guide the brewer and distiller. Were the manufacturer of beer, wine, &c., to practise in like manner as the farmer, and continue but for a few days beyond the period of his accustomed operations, repeatedly to add fresh stimulants to his worts, the products of his labour would be an admixture of alcohol, vinegar, and noxious matter foreign to his purpose. In fact, not any process in which fermentation is requisite, bears the least resemblance to that of the farmer; and yet no reason has ever been given why he should practise to excess, what in all other cases of fermentation it is the leading object of the operator to avoid. The distiller, after each operation, carefully washes his fermenting vessels with a strong solution of white lime in water, to prevent acidity, and the creation of vinegar instead of alcohol. The mixed substances of which farm-yard manure is composed, naturally undergo three stages of fermentation, the vinous, the acetous, and the putrefactive. These follow in regular succession; but if acid be added to wort during the vinous fermentation, this immediately induces the acetous fermentation; or if, in like manner, putrid matter be added, the putrefactive stage is brought on throughout the whole, and heat and action subside sooner in proportion as fermentation has been advanced. Without a considerable degree of heat, life cannot exist in animal or vegetable; and to a certain extent, vegetation and circulation in the fluids of plants are increased according to the measure of heat applied to them; it must, therefore, be necessarily important in this view, that manure should be used at as early a grade of fermentation as may be consistent with other practical purposes, and that neither the acetous nor putrefactive fermentation be allowed prematurely to take place."

Fermentation, both in its establishment and in its continuance, presupposes a certain degree of heat, some proportion of vegetable matter containing gluten, the somewhat free access of the atmospheric air, and a comparatively large proportion of moisture; and when these conditions are not present or pass away, it in the former case cannot be excited, and in the latter case is arrested or made to give place to some different form of chemical action. When the litter or straw of farm-yard manure is not in immoderately large proportion, and when the excrement has been yielded by cattle fed on tolerably rich and succulent food, fermentation readily commences under any of the ordinary circumstances in which the manure is usually collected or laid up in preparation for the soil; but as sometimes occurs on carse farms, or on farms of other kinds which have too small a number of live stock to use up all the contents of the straw-barn as litter,—when the straw of the manure is in excessively large proportion, as compared to the amount of excrement from cattle fed on rich and succulent food, and especially when much of the straw is dry and but little broken, fermentation cannot without more or less difficulty be so far induced and maintained as to bring the whole mass into a fit condition to act fertilizingly upon the soil. A sufficient remedy in many instances of the latter class, is to make as equal a diffusion as possible of both the solid and the liquid excrements, and to keep up an abundant moisture by artificial applications of water during the absence of rain; but a vastly preferable remedy, with the high additional advantage of greatly enriching the manure, is to provide a larger proportion of both excrement and direct vegetable refuse from the cultivation and use of clovers, tares, cabbages and other succulent and nutritive fodder-plants. But even when animal excrementitious matters, are in average proportion, or it may be in unusually large proportion, and when the conditions of heat, air, and gluten are all sufficiently present for maintaining the fermentative process, and when fermentation has actually commenced, and perhaps gone somewhat far in effecting its peculiar results, the mere failure of moisture sometimes suddenly and totally alters the chemical affinities of the whole mass, destroys for a time all its capacity of fermentation, and induces the commencement and perhaps the rapid progress of eremacausis, or it may be of downright combustion. This phenomenon is well known among ignorant and slovenly farmers under the name of fire-fanging; and it speedily reduces any farm-yard manure in which it occurs, even though it were the richest which can be produced from the stable, into a dry, scorched, and burnt condition, of almost utter worthlessness. The recommencement of fermentation after fire-fanging has begun, cannot be effected without much difficulty, and yet is essential to prevent an almost total waste of the manure; and when ever fire-fanging is even suspected, much more when it is known to have made some progress, the heap of manure should be turned over, drenched with water, and mixed as abundantly as possible with some other manure in a state of fermentation, or at least with some kind of dung in not a quite fresh condition.

The Preparation of Farm-Yard Manure.—The proper methods of treating farm-yard manure preparatory to its application to the soil have, in a great degree, been either stated or suggested in what we have said respecting the collecting, the composition, and the fermentation of the manure. Yet some important precautions and directions, partly as inferences from the remarks already made, and partly as supplements or additions to them, have still to be mentioned.

Farm-yard manure ought in all other cases to be treated as nearly as possible in the same manner as in the case of accumulation beneath cattle fed in shelter-sheds; that is, it ought as much as possible to lie in the original place of its deposit, and to accumulate there in a state of seclusion from rain, aeration, and heat, till the time arrive for removing it to the field; and, especially, it ought not to be subjected to such turnings and stirrings as shall expose the interior of even its coat or outer layer to the permeations of the air and the play of the weather. The practice, so prevalent in many agricultural districts, of daily or several times a-day, carrying out dung and litter from the various farm-offices, and accumulating them in a promiscuous mass in a common open dung-pit or open dung-court, gives a constant series of fresh stimulations to the matters deposited below, induces a continual succession of begun and arrested fermentations in the surface strata of the heap, effects the vaporization of a considerable portion of the most valuable elements, and produces chemical changes of a very different kind from such as contribute to fertilization and comport with economy. The litter, in consequence of being lighter than the dung, allows the latter to sink down from it, and forms a strawy coat upon the surface of the heap; and, though this coat protects the dung from the action of the light and the wind, and from the poaching of cattle's feet, it permits a sufficient permeation of air and heat to excite fermentation, and conducts inward to the dung such a quantity of rain as sinks through the whole mass, dissolves much of the most valuable matter, and escapes from below in the form of a powerfully fertilizing but almost totally waste liquid. A notion prevails, indeed—and even receives the sanction of some of the ablest recent writers on agriculture—that because the acetous fermentation in all normal cases requires a genial degree of heat, and proceeds very sluggishly at so considerable a temperature as 50°, it cannot occur in the open yard during the wintry portion of the year, so that no dissipation of useful substance or any other really injurious effect can result from the loose and open accumulation of farm-yard manure, and the constant disturbing and stirring of it by additions from the offices, in the months between the close of harvest and the time of using it in spring. But, in spite of all theory or mere reasoning on the subject, fermentation actually does go on, at almost every season of the year, and may frequently be detected in the very middle of winter by some of its most obvious phenomena. And, besides, to adopt the words of a periodical writer already quoted, "Most animal and vegetable substances, vegetating or dead, are exceedingly influenced by changes in the atmosphere, from causes but imperfectly understood. The freshest straw in the dunghill indicates this by becoming yellow during frost; and that which is mixed with dung and exposed to the air, assumes the dark colour of the liquid matter which oozes from the heap; whilst the succeeding thaw, in its effects, evinces that the whole has by frost been prepared for more rapid dissolution of the most solid materials than at the same temperature previously. Thus the whole are acted upon by every degree of variation in the weather, at every stage; and can it be imagined that these changes take place without the induction of some, and the escape of other volatile principles, or is this irregularity of action consistent with any other systematic process?"

An enormous addition to the evils of heaping up manure piecemeal in the unsheltered yard, is made by the old practice, still observed on some farms, of subsequently forking it up into lofty masses in order to undergo the rotting process of preparation for spring use. A frequent effect of this treatment is the fire-fanging of the central portions of the masses, and the consequent loss of probably from 50 to 70 per cent. of all the valuable principles of the entire manure. "The throwing of it up into high heaps," remarks Mr. Pearson, "is said to be to rot; but to burn would be a more proper expression. I well recollect, when a lad, of being employed to drag down one of these rotting heaps at the risk of burning my feet, as well as receiving a lasting injury to my lumbar vertebræ. Several years ago, I was finding fault with an experienced agriculturist for throwing his manure too thick together, when his answer was, that he always gave his men an extra jug of cider to get them to throw it as high as the barn if they could. I asked, 'Don't you find the middle of the heap as white as your shirt?' 'Yes,' said he, 'but I never could tell how it was,' and added, that it was so dry sometimes that the wind blew it out of the carts. I advised him to save his extra jug of cider, and lay up the manure only from two to three feet in thickness, and not allow a foot to be set on it."

Another evil strictly analogous to the preceding in effect, though considerably different in practice, is, in cases of a common dung-court or dung-pit for all the offices, to accumulate horse-dung in great preponderance near the stable, or not to diffuse it equally among the manure from the other offices; for, in consequence of horse-dung being both far less moist and far more ready to ferment than the other kinds of dung, a loose heap of it rapidly passes into fermentation, and thence into eremacausis or combustion. "The horse-dung," remarks Blakie, "is usually thrown out at the stable doors, and there accumulates in large heaps. It is sometimes spread a little about, but more generally not at all, unless where necessary for the convenience of ingress and egress, or perhaps to allow the water to drain away from the stable door. Horse-dung lying in such heaps very soon ferments, and heats to an excess; the centre of the heap is charred or burned to a dry white substance provincially termed fire-fanged. Dung in this state loses from 50 to 75 per cent. of its value."

Cow-dung, when separately accumulated, incurs fewer risks, and requires less nicety of management, than mixed farm-yard manure, and especially than such manure as contains a large proportion of horse-dung. Manure from the cow-houses and the ox-sheds is the coldest and least ammoniacal of all the manures of the farm-yard, and at the same time is the most easily made available for the use of potatoes, turnips, or other plantings and sowings of the latter part of spring or the commencing part of summer; and, in the practice of some well-enlightened farmers, it is therefore accumulated separately from the other manures in an open pit, and not removed thence or turned, or otherwise disturbed, than by daily additions to its bulk, till it is carted away to be applied to the land. The kind of pit frequently used for it is an enclosure with a strong wall three or four feet high in the centre of a court; and the accumulation is made within this, or even up to a height above its top by means of a wheel-barrow for carriage, and a plank for a roadway.

Manure whose straw has been reaped from comparatively clean fields, or whose excremental constituents are of such a nature as to be easily thrown into fermentation, or whose character in other respects is such as not to require any preparatory stirrings for the destruction of seeds and larvæ, must lie unstirred in the place where it was deposited till it is wanted for use, and then be carted direct out for distribution throughout the field, and for immediate intermixation with the soil. Yet if its ingredients have been collected from different kinds of offices, and have not been equally diffused among one another during the process of deposition, the whole mass of the manure, just before being carted out, ought to be so turned over where it lies that its several ingredients may be properly intermixed, and made to constitute a homogeneous heap. The vastly better practice is to effect equal intermixation, throughout the whole process of the collecting of the manure; but whenever this has been omitted, a special turning of such a kind as to render the whole manure uniform in quality becomes necessary. Any manure which requires a little fermentation to fit it for immediate use, and which is so constituted as not to be difficult of fermentation, may be turned over and allowed to ferment on the spot on which it was collected. In this case, it is so turned over, with large three-pronged forks, from the one side to the other, and from the top to the bottom, that the whole mass becomes reversed; and if allowed to lie undisturbed in its new position, with free exposure to the air, and without being trodden by cattle or otherwise consolidated, it will speedily be in a state of equal fermentation throughout all its parts, and completely fit for immediate application to the soil.

But either when manure requires to be much fermented, or when it is of such a nature as to be difficult of fermentation, or when it accumulates in such quantity as to exceed the capacity of the yard for containing it, or when it cannot all be carried direct to the fields in spring without seriously retarding or embarrassing the other operations of the farm, it must, at some period before the time of its being required for use, be carted away from the yard, and formed into dunghills on the borders of the fields. The case of a required great degree of fermentation is, as we formerly saw, very seldom desirable; and the case of difficulty of fermentation occurs principally in the very small number of farms which produce a much larger proportion of corn than of green crops; and the treatment in both of these cases is to give the manure a sufficient number of stirrings and turnings to accomplish the desired object. But the other two cases of forming dunghills on the borders of the fields are of very frequent occurrence; indeed, they practically occur throughout entire districts of the best agricultural counties; and they even force themselves so prominently on our attention as almost to identify themselves with what the great majority of good practical agriculturists regard as the most approved process of the preparation of manure. Some farms produce such an enormous quantity of manure, that the carting of it out from the yard at the time of being used, could not possibly be effected without mischievously retarding the other operations of the busy season of spring; other farms, though producing but a moderate quantity of manure, have not near space enough within their yards for its accumulation; and most farms have their economy so arranged that the removal of the manure from the yard to the field-border during the dead of winter, can be effected when the horses and the ploughmen have nothing else to do, and is in consequence an economizing of both time and labour.

The removal of manure from the yard, and the laying of it up in dunghills in the field, usually take place at two seasons,—the first toward the end of December, or during the prevalence of hard frost,—and the second, late in spring, or at the transference of the cattle from yard-feeding to the open pastures, and in preparation for the sowing of the turnip crops; and the proper treatment in the former case is considerably different from that in the latter.—In the winter removal, each dunghill, provided the farm and the fields be of moderately large size, may have a breadth of 5 yards, a length of 20 or 25 yards, and a proportionately great height. A bottom for each dunghill, in order to prevent the loss of some of the richest liquid matter by infiltration into the land, should be formed of clay, marl, or some similar substance, to the thickness of 6 or 8 inches. The manure, throughout the whole process of removal, should be as little shaken up or kept as compressed as possible; it should not be forked from the carts to the dunghill, or tossed into small pieces; but the carts containing it should be drawn up to the dunghill; and the contents should be tilted over on the spot where they are to lie, and there be compressed into their sets, or at least as slightly disturbed as will at all comport with the giving of a regular outline to the dunghill. The object of all this is to prevent the induction of fermentation by the operations of the removal, and to make provision for the hinderance of that process till the proper time for it shall arrive,—a time a little before that when the manure shall be required for use. The manure should be emptied regularly and slopingly upon the dunghill, so as to render the ascent easy for the succeeding teams as they come with their loads. As soon as each dunghill is completed, it should be covered all over with a coat of clay, marl, or adhesive soil, technically called "a crust;" and it will then constitute what many farmers jocosely call "a pie," and will keep the manure in a fresh or unfermenting condition, and without any material loss from exhalation or evaporation till the arrival of spring. A point ought to be made, also, of clearing out all the manure of a subdivision of the yard quite to the ground at a single removal; so that the contents of the dunghill may be of uniform consistency and constitution, and that the contents of the yard may neither be roused into fermentation nor made to form a puddled and filthy bed for the cattle. About a fortnight before the manure is required for the turnip grounds, each "pie" should be broken up, turned over, carefully stirred all through or intermixed, and again covered over with a "crust," or coat of clay, marl, or adhesive soil; and a fermentation will then take place quite sufficient to bring the whole mass into a state of excellent preparation either for land to be sown with turnips, or for land to be planted with potatoes, or with any similar crop. Many modifications are practised upon this simple method of a single turning by many farmers, and some very operose and mischievous additions are made to it by some; but, in general, all these modifications and additions are a sheer waste both of the labour of the workmen and the fertilizing powers of the manure; and no other modifications are admissible than such as may, in rare instances, be required by the risk of fire-fanging, the inaptitude of the heap to ferment, or the desirableness either of accelerating fermentation, or of conducting it to the degree of producing considerable 'shortness' in the manure.

In the removal of the manure in spring, or at the sending of the cattle to the open pastures, the dunghills on the field-borders ought to be formed on the same kind of bottoms as the winter-made dunghills, but ought not to be raised either to much height, or in a compressed condition, or with any of the winter precautions to prevent fermentation. They ought, in fact, to be formed in such a manner as to secure by one process the objects both of the winter-formation and the spring-turning of the other dunghills; they ought to be loose, thoroughly intermixed, and not more than two or three feet in thickness; the carts should not be drawn upon them; and their contents should be thrown up lightly with the fork. 'Pies,' thus made, should be covered with earth in the same manner as the winter ones; and they will speedily have their whole mass in a state of sufficient fermentation to be immediately applied to the land. In the case of very rich manure, indeed, the fermentation induced may be too powerful, and may require to be modified. "What is a safe guide in this process," suggests Mr. Pearson, "is to have a few sticks stuck into the heaps; and as soon as they feel warm to the hand, let the manure be turned and laid a little thinner; and should they get hot a second time, turn the manure again." But more than one stirring is always accompanied with great gaseous loss during the process, and a far better method, in any case in which the manure seems at all likely to go into powerful fermentation, is so to dispose it at first, in regard both to depth and to covering, as to occasion the fermentative process to be sufficiently slow.

The Application of Farm-Yard Manure.—The application of farm-yard manure to grass lands has sometimes been practised on good farms, and forms a regular part of practice in some backward districts, and in blind systems of mere imitation husbandry; but it more or less in all circumstances occasions so enormous a waste of fertilizing matter both by gaseous dissipation and the washing of thaws and rains, as to be sternly condemned by all well-informed agriculturists. The spreading of it over the surface of the ground from the beginning of spring till the end of autumn, as is recommended to be done by Mr. Baker, a stout pretender to highly improved practice in the use of farm-yard manure, is simply to expose it to the most powerful possible play of both the mechanical and the chemical actions of the atmosphere, and to render perhaps not one-fourth of it available for the absorption and nutrition of the grasses; and to cart it out and spread it on the land during a season of frost, as was for a long time currently done in the northern counties of England, is but a degree or two less foolish than if the greater portion of it were tilted directly into a river. "While the frost lasts, the land can derive no advantage from the manure; and when a thaw supervenes, it is evident that the wash from melting snow, or from the rains which generally fall in such weather, must deprive the mass of every part that is soluble. The ground, in the meantime, retains the frost for many days, and is therefore incapable of absorbing the wet which falls upon its surface; and even when the influence of the milder air has reached it, can imbibe but little, being in general previously filled with water, and the quantity which flows over it being too great for the soil, under any circumstances, to drink up." Farm-yard manure, in fact, requires to be buried a little within the soil, both that it may escape wasteful dissipation by surface-decomposition and by washing away, and that it may readily and fully perform its fertilizing functions; and it must therefore be regarded as suitable only for tillage-lands, and as properly applicable to these either at the close of a bare fallow, or immediately before the laying down of a green fallow crop.

The quantity of farm-yard manure applied at any one time, or in the course of a short cycle of years, ought simply to be such as to supply an amount of nitrogen, salts, and humus equal to what the preceding crops have extracted, or, in other words, to maintain an uniform and sufficient fertility. It ought neither to give an excess of stimulus in one year, nor to allow a deficiency of it in another; and should be so distributed in time as well as apportioned in amount as to feed all the crops of a rotation as nearly as possible alike. The application of a comparatively large quantity of manure at one time accelerates the decomposition of the whole mass, renders the first crop prurient or plethoric, and comparatively starves the crops which follow; and a heavy dose of it after a thorough summer-fallow, especially if the circumstances of the fallow have been such as to comminute and unusually fertilize the soil, makes the ground so porous in spring, that many of the corn-plants perish for want of mechanical support, and pours around the roots of the whole crop such a profusion of stimulating and nutrient matter as to derange all its organisms with excess of food, and render it far less productive than if not one particle of manure had been applied. In the old husbandry, doses of from thirty to fifty tons per acre were given at one time, and were not repeated till the land became almost completely exhausted; but in the most improved modern husbandry, doses of only from fifteen or twelve to ten tons, or even much smaller quantities, according to the nature of the soil, the quality of the manure, and the exhaustiveness of the crops, are given at one time, and are repeated with sufficient frequency to keep the land in nearly an equable condition of fertility. One manuring is now commonly given to a rotation of four years, when only two of the crops are culmiferous; and two manurings are commonly given to a rotation of eight years or even to one of six. "A moderate quantity," remarks Sir John Sinclair, "is bestowed at once, and the dose frequently repeated. The crops are regularly fed; but never surfeited with a profusion of nourishment. Hence those raised in a regular rotation are more uniformly good, and a greater and more valuable produce is obtained than by the former practice."

Farm-yard manure must be spread and ploughed in immediately after being deposited from the carts, and ought to be spread so equally, divided so minutely, and ploughed in so uniformly that every part of the field, even every square-yard, may receive an equal portion. If left to lie in cart-heaps unspread for a day or two, or if allowed to lie spread but not ploughed in for a very few hours, it will lose so large a proportion of its value and even of its bulk as would seem utterly incredible by every person unacquainted with chemistry; and if deposited unequally in the soil, it will surfeit the plants of some spots, and starve those of others, and in consequence occasion a great subtraction from what would otherwise be the amount of the crops. It cannot, indeed, be distributed so equally when laid in drills for turnips or potatoes, as when intermixed with the whole area of the soil after a summer-fallow; yet, even in this case, it ought to be distributed with a degree of uniformity very nearly approaching to equality. To promote this uniformity the drills are sometimes drawn across the fields, and at other times diagonally; or, entirely to secure it for the subsequent crops of the rotation, the whole field, after the turnips or potatoes are harvested or otherwise removed, is so cross-ploughed as to mix the contents of the drills with the soil of the intermediate spaces.

The manure ought to be buried in the soil at precisely the depth which will occasion it to decompose in a manner and with a rapidity most conducive to the feeding of the successive crops of the period for which it is intended to serve. Any portion of it which may be allowed to lie either on or very near the surface will, as we have already seen, be wasted both by gaseous escape and by the action of heavy rains; and any portion of it which may be buried so deep as to lie beyond the free decomposing action of combined heat, moisture, and electricity, will in a greater or less degree continue inert within itself and unserviceable to the crops. Economically deposited manure lies at just such a depth within the soil as to undergo decomposition with the degree of speed requisite to evolve continuous nourishment to the series of crops,—at such a depth that the principles and elements of it which become gaseous are evolved within the range of the higher spongioles and do not escape direct into the atmosphere, while the principles and elements which become dissolved in water are evolved within the range of the lower spongioles, and do not escape direct into the drains. This depth necessarily varies with the average nature of the plants of the rotation, and especially with the comparative porosity or cohesiveness, warmth or coldness, dryness or moistness of the soil; but, on the average, its level is three or four inches below the surface.

A new method of applying farm-yard manure to land was very confidently recommended, a few years ago, by a Mr. Baker in the vicinity of Leeds, as fitted to produce advantages cent. per cent. greater than those of former methods; and as a very brief statement of it can be given in Mr. Baker's own words, we think well to exhibit it to our practical readers as a very favourable specimen of the numerous quack-novelties which ill-informed pretenders so frequently try to force on their attention. "My method," says Mr. Baker, "is to spread the dung on the land as soon as convenient after it is made, except in winter. The manure made at that period of the year remains in the fold-yard till spring, where it does not ferment. The whole is taken in the spring, summer, and autumn, fresh to the land. If in fallow, it is ploughed in with a thin furrow; the land is harrowed and ploughed again in a fortnight, and in a fortnight after harrowed and ploughed a third time; after which the muck, however long it may have been, is reduced, and the soil will be in as fine and friable a state as the land is capable of. From the time the dung is put on to the last-mentioned ploughing, nothing can be more unsightly than its appearance. If it is to be applied to pasture, I spread it over the surface of the ground from the beginning of spring to the end of autumn. Three essential points are to be observed: first, to apply the manure to the soil as soon as convenient after it is made, except in the depth of winter; secondly, to keep it as near the surface as possible; and thirdly, to mix it well with the soil. These being observed, I confidently assert that advantages equal to double those now derived from manure are communicated to the land by an increase in the fertility of the soil, exhibited in healthier and more abundant crops." Now,—passing over the pasture-land portion of this method, the folly of which was formerly glanced at —see the filthiness, wastefulness, and shortsightedness of the fallow part of it! The practice is exceedingly dirty, and therefore disgusting to both man and beast; the labour in the frequent cartings, ploughings, and harrowings makes large demands on both ploughmen and horses; the pause in winter is a wasteful addition to the pause in almost all other field-work; the successive stirrings of the fallow soil for intermixing the manure prevents the germination and clearance of weeds, and in so far defeats one main object of the fallow; the shallowness at which the whole manure is originally deposited, and the complete exposure to which portions of it are afterwards brought up by the harrows, occasion enormous waste by gaseous dissipation; and the comparatively long period between the depositing of the manure and the laying down of the crop, is simply a period of decomposing, expending, and dissipating the most solvable portions of the manure, without the possibility of a particle of benefit accruing to the farmer. Yet we cannot doubt Mr. Baker's veracity when he assures us, as he does, that "the success of his method has been proved by numerous experiments." But, then, what are the methods of applying manure which he pronounces worse than his own, or which he discarded and condemned for the sake of his own? Are they the methods of the best agricultural districts, or methods in any considerable degree similar to those which we have recommended? Not at all; but entirely the old methods of rotting, dissipating, and consuming the manure down to the condition of "short dung." "Manure of almost every description," says he, "is carried from the place where it is made, and deposited on a heap for four, six, or eight months, where it ferments, and becomes a soft, black, cohesive mass; it is then put on the land and ploughed down, after which the crop is sown. This may not always be done; but something resembling it is the prevailing and general practice in every part of the country." So, after all, the only lesson from Mr. Baker's experience is this,—that unfermented manure, even when applied in his enormously wasteful method, is twice as beneficial to the crops as manure fermented down to the condition of "soft, black, cohesive" short dung! How eminently superior then must be manure prepared and applied in the common sense method of the most improved modern practice!—*Blakie on Farm-Yard Manure.—Dr. Fenwick's Essays.—Dana's Farmer's Muck Manual.—Dana's Prize Essay on Manures.—Liebig's Chemistry of Agriculture.—Chaptal's Chemistry applied to Agriculture.—Turner's Elements of Chemistry.—Armstrong's Treatise on Agriculture.—Communications to the Board of Agriculture.—Marshall's County Reports.—Mill's Husbandry.—The Farmer's Magazine.—The Quarterly Journal of Agriculture.—Sir John Sinclair's Code of Agriculture.—Sir John Sinclair's General Report of Scotland.—Low's Elements of Agriculture.—Stephens' Book of the Farm.—Boussingault's Rural Economy.—Davy's Agricultural Chemistry by Shier.—Journal of the Royal Agricultural Society.—Dickson's Husbandry of the Ancients.—Society of Gentlemen's Complete Farmer.—Doyle's Practical Husbandry.*

FARRIER. A person who fabricates the shoes of horses, fastens them on, and professes to cure diseases in horses' feet. He held, till quite a recent period, the same sort of relation to the practice of the healing art for horses and cattle, which barbers held in the middle ages for human beings; or he even was the only medical practitioner whatever for the domestic animals of the farm; and he hence has bequeathed the name of farriery to the whole of the veterinary art. But a farrier was a grossly ignorant person in comparison to the modern veterinary surgeon; he had little knowledge of the materia medica, and usually none of anatomy and physiology; he was a quack as regarded the cure of diseases, and frequently a cruel bungler as regarded the treatment of sores; and he frequently possessed but a pitiful acquaintance with the principles of his proper vocation as a maker and adjuster of horses' shoes. Not a few farriers in remote districts at the present day have a considerable resemblance to the quack-farrier of former times; but the regular, well-educated, professional veterinary surgeon is a thoroughly respectable person, often as well acquainted with anatomy, physiology, and the powers of medicine as a good surgeon or physician of the human subject, and fully entitled to pronounce the name farriery, when understood in anything like its original signification, a foul libel upon his art.

FARRIERY. See Farrier.

FARROWING. The parturition or littering of the sow. She is said to farrow when she brings forth her pigs; and the number of her young ones produced at one farrowing are called a farrow or a litter.

FARSETIA. A genus of ornamental plants of the cruciferous order. Six species of it are cultivated in British gardens; and three others, which formerly belonged to it, are now included in two other genera. The species in cultivation are not very like one another; and might readily be mistaken by a novice for respectively alyssums, lunarias, wall-flowers, and aubrietias. The wall-flower-leaved species, *F. cheiranthifolia*, is a hardy annual of a foot in height from the Levant; and most of the others are slightly tender evergreen undershrubs. All, except one, are yellow-flowered.

FARTHING-BOUND. Costiveness in the cow. See the article Costiveness.

FARTHINGDALE. A rood,—the fourth part of an acre.

FASCIA. An unnatural growth of twigs, in the form of a bunch, upon the branch of a tree. A knot or tumour is first formed; and a multitude of shoots then grows out in a manner so interwoven and intricate as to form a bunch which, when seen at a little distance, looks like a wood-pigeon's nest. The cause of this phenomenon has been supposed by some phytologists to be extravasation, or a rapid, plethoric, and surfeiting ascent of sap; but it seems really to be a puncturing by insects,—the same cause which frequently originates tumours in the stems and roots of some herbaceous plants. Fascias are popularly known in Scotland under the name of witches' knots; they occur most frequently in the ash and the birch; and they often give to trees either a picturesque or a very curious appearance.

FASCIOLA. See Fluke.

FAT OF ANIMALS. Animal oils and fats, as they differ only in the fluidity of the former at common temperatures, while the latter are generally concrete, will be treated of together in the present article. Of animal oils, whale oil and sperm oil are most generally known in this country; and among the principal varieties of fat are spermaceti, butter, tallow, lard and suet.

Whale oil, or train oil, is extracted from the blubber of the whale,—principally the *Balæna mysticetus*. Originally, it is a firm solid fat. To obtain the oil, the blubber is melted in large copper vessels. A large quantity of water separates, and on the surface there floats a solid matter, called *fenks*, which is probably coagulated albumen. The more moderate the heat, and the shorter its duration, the paler and better is the oil; but this is attended with a diminution in its quantity. The deep colour is owing partly to too great heat in the boiling and partly to blood and other impurities, which are unavoidably mixed with it. What is extracted in Greenland is perfectly pale and limpid, and free from smell, and burns with a pure and bright flame. Whale oil requires to be kept in close vessels to prevent the action of the air. It is rendered more fluid and combustible by adding to it a little cold-drawn linseed oil; but it cannot, by any treatment, be made so fit for burning in lamps as spermaceti oil. The best way of using it is found to be by converting it into gas. It may be deprived of its offensive odour, however, by the use of chloride of lime. Its specific gravity is 0.9191. It boils at 640° Fahr., and may be distilled; but its properties are then materially altered, or, rather, it becomes a new substance, its specific gravity being diminished to 0.868, its boiling point lowered, and its inflammability much increased. Whale oil consists of carbon 68.87, oxygen 16.10, and hydrogen 15.03.

Sperm oil, or spermaceti oil, forms part of the oily substance found in the cranium of the spermaceti whale, or *Physeter macrocephalus*. The oli is separated by putting the mass into a woollen bag, and pressing it, by which the fluid is made to run out, and the solid residue, when washed with a weak alkaline ley, affords spermaceti. This kind of oil is much purer than train oil, and burns away without leaving any charcoal on the wicks of lamps. In composition, it differs but slightly from whale oil, consisting, according to Ure, of carbon 78, oxygen 10.20, and hydrogen 11.80.

The fat of animals, or more solid animal oils, may be separated from the membranous and other substances with which it is united, by melting it at a gentle heat, with the addition of a small quantity of water. Fat thus prepared is called *lard*, when of a soft consistence, and *tallow* when harder. It is insipid, and sometimes free from smell; at others, it has a distinct and peculiar odour. It is apt to become rancid, however, by keeping—a change connected with the absorption of oxygen. It is insoluble in water or in alcohol. It melts at 90° or 100° Fahr.: by raising the heat, it is rendered more acrid, and exhales a pungent vapour. In close vessels, it is decomposed, and, among other products, yields a large quantity of olefiant gas. It is inflammable, and affords, by combustion, water and carbonic acid. The acids act chemically on fat. Sulphuric acid chars it. Nitric acid, mixed with it in small quantity, gives it a firmer consistence, and renders it soluble in alcohol. In this state, it has been called *oxygenated* fat. The animal oils and fats combine with the alkalies, and form with these perfect soaps. With some of the earths, and metallic oxides also, they form saponaceous compounds They even facilitate the oxidation of some of the metals, as copper and mercury, by the atmospheric air. Animal fat is not homogeneous, but consists of two different proximate principles, called *stearine* and *elaine*, the former of a firm consistence, resembling suet or tallow; the other more soft or liquid, and analogous to vegetable oils.

FAT-HEN. Any indigenous goosefoot which grows upon a dunghill or in any similar situation.

FATHOM. A measure of length, amounting to two yards or six feet, and used principally for measuring cordage and sounding seas and mines.

FATTENING OF ANIMALS. The feeding of oxen, sheep, and pigs for the butcher. This practice is, in some circumstances, more remunerating to the farmer than the practice of the dairy; and it possesses the additional advantage of bringing a quicker return for the outlay of capital. The kinds of food most suitable for fattening, are not the same as those most suitable for strengthening; the quantity of food requisite for producing fat, is as variable as the quantity requisite for producing milk; and the sort of treatment which succeeds best in rapidly accumulating fat, is totally different from the sort of treatment which succeeds best in rapidly improving the muscles. The quality of food for fattening ought to contain an excess of hydrogenous principles, and to exhibit the largest possible proportion of nutritive matter within the smallest possible compass of bulk; the quantity of food ought to be controlled by the circumstances of its own composition, of the season, of the breed, the age, and the condition of the animals, and by other considerations; and the general treatment ought to be such as will produce constant repose, and avert disturbance, and keep up a frequent inclination to sleep. The particular breed of cattle has a powerful control over both the process of fattening and the quality of the flesh; for some breeds are obstinately lean or constitutionally ill-fleshed, under even the most favourable circumstances; while others, whenever properly fed and treated, accumulate fat with great rapidity, and always surrender to the butcher a carcase of the most savoury character. See the articles CATTLE and BREEDING. In every process of fattening, the feeding-house ought to be kept thoroughly quiet, somewhat dark, perfectly clean, and constantly well ventilated, the litter ought to be soft and abundant, and the food ought to be nicely adapted to the conditions which we have already hinted, and to be given with perfect regularity.

"In fattening during winter," says M. Boussingault, "which is done almost exclusively with hay in some countries, an ox weighing 748 lbs. upon 40 lbs. of hay per diem, will increase by about 2 lbs. daily. According to Mr. Low, an ox weighing 770 lbs. and consuming about 2,223 lbs. of turnips per week, if he thrive, will gain in the same space of time nearly a stone in weight. In the information obtained in the Rhenish provinces by M. Moll, in regard to the fattening of cattle under the influence of a regimen which would give 11 lbs. of hay to every 100 lbs. of dead weight, the animal will increase one-third in weight in the course of three or four months." M. Boussingault then states the result of an experiment designed to ascertain the increase of the weight of cattle from different alimentary regimens, and made upon three lots, of six each. of two-year-old oxen, which had been brought up in the same farm, and kept in the same manner,—the experiment being carried on during 119 days, and the weight of each lot being ascertained both immediately before it began and immediately after it closed. The first lot was fed upon turnips, linseed oil-cake, beans, and oats, and also received, during the last 24 days, a daily allowance of 20 lbs. of potatoes to each ox; the second lot was fed upon turnips, beans, and oats, and also received during the last 24 days a daily allowance of 10 lbs. of potatoes to each ox; and the third lot was fed wholly upon turnips. Now, during the 119 days the first lot consumed 1,518 lbs. of white turnips, equal to 171½ lbs. of hay,—13,336 lbs. of swedes, equal to 1,973¼ lbs. of hay,—358 lbs. of beans, equal to 1,559¾ lbs. of hay,—389 lbs. of oil-cake, equal to 1,768 lbs. of hay,—173 lbs. of oats, equal to 279 lbs. of hay,—and 479 lbs. of potatoes, equal to 151 lbs. of hay; the second lot consumed 1,628 lbs. of white turnips, equal to 184½ lbs. of hay,—13,384¾ lbs. of swedes, equal to 1,980 lbs. of hay,—358 lbs. of beans, equal to 1,559 lbs. of hay,—173 lbs. of oats, equal to 279 lbs. of hay,—and 239¾ lbs. of potatoes, equal to 77 lbs. of hay; and the third lot consumed 1,122 lbs. of white turnips, equal to 127 lbs. of hay,—and 12,012 lbs. of swedes, equal to 1,777½ lbs. of hay. The first lot, thus, consumed food equal to 49.7 lbs. of hay per day, or a total of 5,904 lbs.; the second lot equal to 34.3 lbs. of hay per day, or a total of 3,971 lbs., and the third equal to 16 lbs. per day, or a total of 1,905 lbs. Each ox of the first lot, on the average, weighed 1,115 lbs. at the beginning of the experiment, and acquired increase of weight at the rate of 2 lbs. per day, or altogether of 247½ lbs.; each of the second lot, on the average, weighed 1,016 lbs. at the beginning of the experiment, and acquired increase of weight at the rate of 1.9 lb. per day, or altogether of 231½ lbs; and each of the third lot, on the average, weighed 794 lbs. at the beginning of the experiment, and acquired increase of weight at the rate of 0.9 lb. per day, or altogether of 112½ lbs. Thus, for every 100 lbs. of live weight in the first lot, the average daily consumption of food was equal to 4.01 lbs. of hay, and the total increase of weight during the 119 days was 2.22 lbs.; for every 100 lbs. of live weight in the second lot, the average daily consumption of food was equal to 3.03 lbs. of hay, and the total increase of weight during the 119 days was 22.8 lbs.; and for every 100 lbs. of live weight in the third lot, the average daily consumption of food was exactly 2 lbs., and the total increase of weight during the 119 days was 14.2 lbs. "It therefore plainly appears," says M. Boussingault, "that the lot which had the largest allowance of provender, the food which contained the greatest quantity of azotised principles, produced the largest amount of dead weight in a given time, and that the lot which had the shortest allowance, increased in the smallest measure both in flesh and fat,—results which might have been readily foreseen. It is also apparent that in proportion to the nutritive value of the articles consumed by each lot, the increase in carcass weight was greatest in that which received its allowance in the least bulk. This fact is most readily explained; over a certain limit, the more food an animal receives, the smaller is the fraction which is assimilated and turned to use in the body. Breeders have consequently discovered that it is by no means generally advantageous to push animals beyond a certain point of fatness. The excess of weight which is obtained with the assistance of quantities of food, exaggerated as it were, no longer compensates for the additional expense incurred."

Cattle readily fatten in the house upon green clover or lucern. An ordinary ox will eat in the course of a day about 1 cwt. of clover cut when in flower; and if he should suffer injurious relaxation of the bowels when fed with this fodder, he ought to receive a small proportion of dry hay along with it, and eventually or in the last stage of his fattening a little oil-cake. When cattle are fed chiefly on pasture, only the most luxuriant kinds of grass lands, or fields with the richest and most azotised species of the grasses, will fatten them; for many meadows which are sufficient for rearing and supporting bullocks, possess but feeble power of bringing the animals into condition for the butcher. "Those countries where the climate is moist, but long droughts rarely felt, where neither the summer heats nor the winter colds are excessive, the conditions, in fact, which are met with in the beautiful pasture lands of England, in especial, are those that prove most favourable to the rearing and feeding of cattle. The pasture lands of Normandy and Brittany in France, of Switzerland, Holland, several of the provinces watered by the Rhine, &c., are also remarkable for their luxuriant herbage. In such situations, and with such advantages, the grand object with the farmer is the production and fattening of cattle." In many districts of rich pasture lands, some of the best fields and meadows are regularly and most successfully in use for the fattening of oxen. The average extent of a meadow of the greatest fertility requisite for the fattening of a large ox is 2,760 square yards; and of a meadow of medium fertility, 4,680 square yards. "M. Dubois"—we again quote from Boussingault—"finds that a lean ox weighing 473 lbs., after fattening in the valley of the Auge will weigh 763 lbs., so that he will have gained 290 lbs. The degree of fatness attained in this district is often prodigious. M. Dubois mentions oxen which weighed when fat 1,760 lbs., upwards of 125 stones; and he speaks of one which attained the enormous weight of 2,750 lbs., upwards of 196 stones. M. Dubois calculates the quantity of green fodder consumed by an ox, during the eight months when he is fattening, as equivalent to 6,600 lbs. in dry hay. This at least is the quantity which the extent of meadow required to fatten one ox would produce. The average ration of green forage per day is, therefore, equivalent to about 27 lbs. of hay,—a quantity which appears small, and which would be so in effect were not the oxen kept so long in the meadows. M. Dubois indeed observes that in the stall, with a ration composed of from 11 lbs. to 13 lbs. of linseed oil-cake and 26 lbs. of hay, an ox will become sufficiently fat for the butcher in 70 days, and will acquire nearly the same weight which he would have gained in the course of 7 or 8 months in the meadows. There is nothing surprising in this fact, inasmuch as the ration mentioned by M. Dubois, in our mode of viewing it, is equivalent in nutritive value to at least 81 lbs. weight of hay. The quantity of oil-cake alone is enough to supply a good pound weight of fat per day. In Old Friesland, where the pastures are excellent, results are obtained which may be compared with those of the meadows in the valley of the Auge. An ox of from 770 lbs. to 990 lbs. weight will be pushed to a weight of from 1,100 lbs. to 1.650 lbs., on a surface of meadow land between 3,000 and 3,600 square yards in extent. In the meadows of the Auge, the fattening goes on even during the winter. The oxen are received into the pastures between the 15th of September and the 15th of November, and they pass the winter in the open field; but they receive from 12 lbs. to 26 lbs. of hay per day until the month of April, when the grass has already grown sufficiently to suffice for their keep." See the articles CATTLE, BREEDING, FAT, OX, FEEDING, FOOD, FODDER, SHEEP, and GRASS LANDS.

FEABES, or FEABERRIES. See GOOSEBERRIES.

FEAL. The pared sward or turf of pasture land. It is often used in the Scottish Highlands both for the construction of turf-walls or fences, and for mixing up into a compost with farm-yard manure or with other fertilizing materials. A wall constructed wholly or partially of pared sward is called a feal-dyke; and a compost which contains a considerable proportion of reduced sward is called feal-muck.

FEATHER. See Feathers.

FEATHERFOIL, or Water-Violet,—botanically *Hottonia*. A small genus of ornamental plants, of the primrose order. The marsh species, *Hottonia palustris*, is a perennial, indigenous aquatic, of some parts of England. It grows in the clear water of ponds and ditches. Its root is creeping; its leaves are crowded, three or four inches long, bright green, compoundly pinnate, and wholly submerged; its flower-stems are about a foot long, and rise boldly above the water; and its flowers are produced in numerous whorls, have a kind of carmine or flesh colour, possess a similar shape and size to those of the common primrose plant, bloom in July and August, and have a very elegant appearance.

FEATHER-GRASS. See Stipa.

FEATHERS. The exterior covering or plumage of birds. Every feather, though appearing to a careless observer to be a very simple object, is really an intricate and exquisitely beautiful piece of mechanism; and, in many ways, with most impressive effect, in its intrinsic construction, in its mode of growth, in its vital organism, in its chemical elaborations, in its combination with the other feathers into coat and wing, and in its whole circle of adaptations to the configuration, habits, and flight of birds, it displays the beneficence, wisdom, and glory of the Creator. Even a feather, therefore, all trivial though it seem to be, has been most imposingly discussed in some physico-theological treatises, as both a proof and an illustration of omniscient and all-benevolent design in the objects which people the material world.

Feathers are closely allied in chemical composition to hair and wool; and, though they decompose slowly, they constitute a very rich manure; and, if either made up as an ingredient of a compost, or ploughed into the land a considerable time before their resolved elements are required to serve as the food of plants, they act very fertilizingly for any crops which need much nitrogen, and especially for hops, for vines, and for fruit-trees. The rays or pinnæ of feathers were ascertained by Scherer to consist of 50.434 per cent. of carbon, 7.110 of hydrogen, 17.682 of nitrogen, and 24.774 of oxygen; and the quills of feathers were supposed by Hatchett to be coagulated albumen, and ascertained by Scherer to consist of 52.427 per cent. of carbon, 7.213 of hydrogen, 17 893 of nitrogen, and 22.467 of oxygen.

The feathers of the poultry-yard of the farm ought all to be carefully collected and economized. The best feathers of the wings of geese, and sometimes those also of the wings of ducks and hens, may be profitably sold to the manufacturers of quills; the best of all the other kinds of feathers may be profitably gathered for the stuffing of beds and pillows, either by the housewife or by the manufacturer; and all the inferior and refuse feathers may be profitably gathered into a common receptacle with hair, wool, horn, and similar animal substances, for use as rich but slowly-decomposing manure. "Every one," says a writer in the 10th volume of the Quarterly Journal of Agriculture, "is aware that the feathers of cocks and hens are very inferior to those of geese and ducks, for the purpose of filling beds and pillows; and consequently it is scarcely necessary to mention that the former should be kept separate from those of the two latter fowls. As the birds are plucked, the large feathers should be selected and placed asunder. Paper bags are the best recipients. The pinion feathers should be stripped from the quill, and added to the other feathers; and if great caution have not been used in plucking the birds, they should be carefully looked over to see that no part of the skin has been torn, and is adhering to the base of the quills, as it would putrefy and become almost incurably offensive." Feathers gathered for stuffing, and found to be tainted by the adhesion of some skin, may be boiled during five minutes in canvass or calico bags, and dried by a week's suspension in the open air; and they will then be quite free from taint.

FEBRIFUGE. Any medicine or medicinal appliance which alleviates or subdues fever.

FEBRUARY. See Calendar.

FECULA. Starchy matter, or pure starch in partial mixture with water.

FECUNDATION. The generative excitement of the rudimental principle of the seeds of plants and of the embryos of animals. Artificial fecundation of plants, by the transferring of the pollen of one variety or species to the pistil or ovary of another, constitutes the art of hybridizing; and this, in some rare cases, has been effected with pollen which had been kept for some weeks.

FEDIA. See Cornucopia.

FEE, in law,—*feudum*. An inheritable estate in land, held of some superior, or lord; in this sense, it is distinguished from *allodium*, which is the absolute property in land. It is the theory of the English and the Scottish law, that all the lands of the kingdom, except the royal domains, are held in fee, or by a tenure, of some superior lord, the absolute or allodial property being only in the king, so that all the tenures are strictly feudal. This was a very significant, practical doctrine, while the feudal system flourished in Europe in all its vigour; and the remnants of it are still blended, in a greater or less degree, in the land-titles, but rather as a theoretical doctrine, from which certain inferences are drawn, than a plain, direct, practical fact; for the property of the proprietor in land held in fee-simple, in Great Britain, is as absolute, to all intents and purposes, as the amplest estate that can be held in lands in the United States, where the land titles are allodial, there being no practical or theoretical doctrine of a tenure, or holding under a superior. In all countries, property in lands.

as well as chattels, is derived through the laws, and is guaranteed by the government; and, universally, the property, in both lands and chattels, reverts to the government, in case of their being no person who can claim it, either as an heir or purchaser; though, in respect to personal property, the government does not always avail itself of the right, but grants the property to persons who find it, in certain cases. But this right to inherit, or succeed to property, in the absence of all other claimants, who have any right, is not what is meant by the theoretical, abstract property, which the king is supposed to have in all the lands of the kingdom, but of which he cannot now avail himself, in respect to a great part of them, to any practical purpose whatever. In the strict sense of *fee*, therefore, there would be no such thing in the United States, where the titles to lands have no tinge of the feudal system. But the word *fee* is used there as well as in England; and in the same sense, except that, in England, it refers to this theoretical, abstract, absolute property of the king in all the lands; whereas, in the United States, it has no similar reference or implication; the property of the owner in his lands being considered as absolute as his property in his goods, or his dominion over his own person, in respect to all which his rights are subject to the laws, but not more so in respect to real property than in any other respect; nor is this subjection understood to impair or qualify his property, which is, notwithstanding, considered to be absolute. The amplest estate is that of a fee-simple; and such an estate can be had only in property that is inheritable, and of a permanent nature; for we speak of a fee-simple in lands and franchises, but never in ships or goods. Though tenements are said to be possessed in fee-simple, yet this is in reference to the land, which includes things attached to it; but if one puts a building upon another's land by his permission, the building is his personal property, in which he cannot have a fee-simple; but, if he puts it on his own land, he then may have a fee-simple in the land and tenement, considered as one subject. A fee-simple is the estate out of which other lesser estates are said to be carved; as a fee-conditional, such as a fee-tail, and a base fee, which is also, in effect, a conditional fee; as, if land be granted to certain persons, tenants of D, who are to have the lands only as long as they continue to be tenants of D,—this is a base fee. A conveyance to a grantee and his heirs generally, and without qualification, gives a fee-simple; but if the estate be limited to certain heirs, or limited in time, or have any condition or qualification, which may defeat, or terminate it, it is something less than a fee-simple.

FEED. The quantity of oats or of other provender given at one time to any domestic animal, but particularly to a horse. The feed of oats for a horse varies in quantity in different districts; but it ought, for the sake of uniformity of treatment during journeys and after removals, to be everywhere understood as amounting to a gallon or the eighth part of a bushel, weighing on the average about 4½ lbs.

FEEDER, in canal-building. In order that water may not be wanting in any part of a canal, built on different levels, a supply is insured at the highest level, and thus gradually passes off, through the locks, to the lowest. The streams, which furnish the water at this and other points, are called *feeders*.

FEEDING OF ANIMALS. The dietetic treatment of animals, as to at once the kinds, the quantity, the frequency, the preparation, and the condition of their food, and the external circumstances under which it is given. The sorts of food proper for man are noticed in our article ANIMAL FOOD; the sorts of food proper for the lower animals of the farm are noticed in our articles FOOD and FODDER; the elementary constituents of the proper food of both man and the lower animals are noticed in our articles ALIMENTARY PRINCIPLES and NUTRITION; the special feeding of some animals for particular purposes is noticed in our articles CALF, COW, and FATTENING OF CATTLE; the general dietetic treatment of the several classes of farm animals, is noticed in our articles CATTLE, OX. HORSE, SHEEP, HOG, and POULTRY; the preparation of food for the animals of the farm-yard or farm-offices, is noticed in many of our articles, particularly BOILING, STEAMING, CHAFF-CUTTER, BRUISING CORN, and BARN MANAGEMENT; and the external circumstances under which the food of farm-animals is administered are also noticed in many of our articles, particularly COW-HOUSE, OX-SHEDS, STABLE, STELLS, CALENDAR, SHELTER, and FARM-BUILDINGS. Though the topics proper to the present article, therefore, might be discussed at great length, and pursued through multitudes of ramifications; yet, to prevent wasteful repetition, they must be restricted within such limits as shall not invade those of any of the articles now named.

The General Principles of Feeding.—A pervading law in all proper feeding of animals, but one which in several instances is grossly violated in the dietetic treatment of the live-stock of multitudes of farms, is the use of as large a proportion of nitrogenous principles as shall maintain the normal amount of nitrogen in the assimilations and secretions of the animal system. Nitrogen is emphatically the characteristic element of both animal organism and animal aliment,—not only in the case of carnivorous animals, but in the case also of the herbivorous, and especially of the granivorous; and whenever it is not present in due quantity in the food of any individuals, they cease to acquire substance, begin to lose strength, and eventually lose constitutional vigour and healthiness, and sink into emaciation and death. "The increase of the mass of the body, the development of its organs, and the supply of waste," says Liebig, "are all dependent on the blood, that is, on the ingredients of the blood; and those substances only can properly be called nutritious, or considered food, which are capable of conversion into blood. To determine, therefore, what substances are capable of affording nourishment, it is only necessary to ascertain the composition of the food, and to compare it with the ingredients of the blood. But the chief ingredients of the blood contain nearly 17 per cent. of nitrogen; and no part of any organ of the body contains less; and animals cannot be fed on matters destitute of nitrogenised constituents. But vegetable fibrine, vegetable albumen, and caseine are the true nitrogenised constituents of the food of graminivorous animals." He then shows that these three principles contain the same elements, in the same proportion by weight, and are identical in composition with animal fibrine and animal albumen, the nitrogenised and most important constituents of the blood. Dumas also has traced and demonstrated the perfect parallelism between the nitrogenous vegetable principles as they exist in seeds and other esculent parts of plants, and the nitrogenous animal principles as they exist in the organised system of animals. Vegetable fibrine and vegetable albumen, in fact, hardly differ from animal fibrine and animal albumen even in form; and the former are simply the latter in a state exterior to the animal system, and of elaboration independently of it, and of thorough preparedness, under the benign arrangements of the Creator, to be taken into it for its appropriation and support. When, therefore, the nitrogenous principles are a-wanting in the stated food of animals, the very flesh and blood must rapidly die out for want of aliment; and when these principles are in deficient quantity, the flesh and blood will fail exactly in the proportion of the deficiency.

An important and familiar illustration of this rule,—quite sufficient to show the necessity of attention to it in all the departments of feeding live-stock,—is afforded by the alimenting of sheep or cattle upon turnips. The proportion of the nitrogenous principles in turnips is enough to prevent any perceptible diminution of strength, and even enough to promote a certain degree of growth and healthiness, but not near enough to produce a maximum or even a normal development of bulk and energy in the animal system; so that sheep fed on turnips cannot duly thrive, and will not favourably fatten unless they receive also a portion of the cereal grasses, of oil-cake, or of some other highly nitrogenous food. "According to Dr. Daubeny," says the Rev. W. Thorp, "turnips contain in about 50 tons, or 100,000 lbs. weight, 92,762 lbs. of water and carbon, 5,558 lbs. of fixed ingredients, and 1,680 lbs. of azote. Now 25 tons, being an average weight for one acre of land, will only contain 840 lbs. of nitrogen; hence we may see the necessity of adding grain, as practised by Messrs. Childers and Thompson. The former states that sheep fed with the addition of half a pint of barley per sheep per day, half a pound of linseed-cake, a little hay, and with a constant supply of salt, become ready for the butcher in ten weeks, and gain of flesh and tallow 33 lbs. to 40 lbs. per head,—(one sheep gained 55 lbs. in twelve weeks),—and that, with artificial food, 30 tons of turnips will feed 60 sheep; while, on the usual plan of feeding on turnips alone out of doors, the average of the country is that 20 tons of turnips will feed 10 sheep in 16 weeks, with a gain of only 20 lbs. of flesh and tallow. The barley and cake cost from 6d. to 10d. per week for each sheep; and the turnips with this addition thus go eight times as far, or produce eight times the amount of flesh and tallow. The turnips alone go four times as far, for 30 tons feed 60 sheep, while on the usual plan of feeding they would only feed 15 sheep; but the same weight of turnips with artificial food produces also very nearly double the amount of flesh and tallow, and therefore goes eight times as far. The practice of Belgium is also in strict conformity with the principles laid down by Professor Liebig; for not only are all their animals kept up and fed in houses, but the mixture called brassin consists of the flour of nitrogenous grain mixed together with roots." See the article Brassin.

Another pervading law in all proper feeding of animals, and one which has been grievously overlooked in almost all experiments for ascertaining the relative effects upon cattle of different kinds of food, is the maintaining such a warmth by shelter during the cold season of the year as shall prevent a wasteful expenditure of animal heat by radiation into the atmosphere, and therefore a wasteful expenditure of aliment in producing volumes of heat in lieu of those lost by radiation. The living systems of animals constantly assimilate large quantities of carbon and hydrogen from their food; the mutual action of oxygen and these elements of food is supposed to be the chemical accompaniment of their vital heat; and the dissipation of the carbon and part of the hydrogen from the blood by oxygenizement or the formation and expulsion of carbonic acid and aqueous vapour, are supposed to be the chemical accompaniment of respiration; so that the amount of nourishment required by the animal body, or at least of the carbonaceous and hydrogenous elements of nutrition, is theoretically assumed, and has been practically tested, to be proportionate to the expenditure of heat generated within the system, whether that expenditure have the form of accelerated breathing and increased perspiration occasioned by exercise, or of excessive radiation occasioned by the relatively low temperature of the surrounding air. The clothes of man and the shelter of brutes, therefore, serve in winter as an equivalent for a certain amount of food. The more warmly men are clothed and brutes are sheltered, within certain limits, the less food will they consume; and the less protected they are from the colds of winter, also within certain limits, the more food do they require. "If," says Liebig, "we were to go naked like certain savage tribes, or if in hunting or fishing we were exposed to the same degree of cold as the Samoyedes, we should be able with ease to consume 10 lbs. of flesh, and perhaps a dozen of tallow candles into the bargain daily, as warmly clad travellers have related with astonishment of these people. We should then be able to take the same quantity of brandy or train-oil without bad effects, because the carbon and hydrogen of these substances would only suffice to keep up the equilibrium between the external temperature and that of our bodies." Want of attention to the conservational power of comfortable external heat upon internal aliment has utterly vitiated multitudes of experiments respecting the feeding properties of different kinds of food, and occasions, throughout the kingdom, a stupendous amount of constant wasteful expenditure of winter provender. "If," says the Rev. W. Thorp, "we apply this to the want of shelter to our sheep while feeding upon turnips in the winter season, when the temperature of the nights is frequently below the freezing point of water, and this over three millions of acres of turnips in the kingdom, we shall find the loss of food very great indeed. Mr. Childers of Cantley and Mr. H. S. Thompson of Kirby Hall have, upon a small scale, fed sheep in sheds during the winter; and the former says that the sheep in sheds consume nearly one-fifth less food and make one-third greater progress, than those fed with the very same food in the open field, or very nearly the same food will feed double the number of sheep. Mr. Morton informed Professor Playfair that 200 sheep in the open field eat 24 lbs. of swede turnips each daily, while another 100, having a covered shed and a yard to run into at pleasure, only eat each 20 lbs. of swedes."

The Feeding of Horses.—The feeding of horses ought to be modified according to the circumstances of climate, natural herbage, season of the year, the state of the animals' health, and the kind and degrees of their labour. Horses brought up in a severe climate, on hard fare, and with scantiness of nourishment would be injured by such nice, comfortable, and profuse dietary treatment as is essential to the strength and health of horses brought up amidst genial warmth, on fine food, and with constant abundance of provender. The proper food of farm horses may be classified into green herbage, dried herbage, grain, pulse, roots, mixtures, and cooked food. All the simple kinds of these are fully considered in the article Food, and in the numerous articles on the respective nutritive plants and parts of plants which are there enumerated. Mixtures of several kinds are now in much use; they can be varied to suit the different circumstances of horses, as to at once season, habits, health, and labour; they can be so modified as to act medicinally, as alteratives, as tonics, as aperients, or in other capacities; and they have been proved by abundant trial to be both economical and grateful, both convenient and efficient. One excellent sort of nutritive mixture consists of one part of chaffed or thoroughly cut prime hay, two parts of chaffed or thoroughly cut clean straw, and one part of well-bruised but not ground grain of oats. Cooked food, consisting principally of potatoes, turnips, parsnips, and carrots, possesses some of the properties of chyme, saves the toil of mastication, enables a feeble horse to swallow a given portion of nourishment in a twelfth or an eighteenth part of the time requisite for receiving it in the form of dry hay, and is well suited to the general condition, and especially to the weakened digestion, of horses which have been injured by very severe labour.

Colts are kept in pasture fields during summer, and in open sheds of the farm-yard during winter; yet, whenever the circumstances of a farm can afford such accommodation, they ought, throughout the winter, to have free access to a paddock, and to be kept alternately there and in the sheds, according to the temperature of the weather. The time for removing them to the pastures is as early in spring as sufficient herbage can be found for their support; and the time for removing them to the farm-yard, is when the herbage ceases to be sufficient, whether wintry temperature have commenced or not. They ought, like young oxen, to enjoy abundance of litter in the sheds; and they may be fed during the former half of winter upon straw and green food, and during the latter half on hay and green food or turnips; and, in order to prevent retardation to their growth and permanent injury to their strength, they ought at all seasons to receive abundance of nourishment.

The dietetic treatment of the teams or working horses of farms, is exceedingly different in different districts and at different seasons; and for the purposes both of health to the animals and of economy to their owners, it admits of considerable variety in the department of shelter, and of very great variety in the department of food. The following method is recommended by Professor Low as both simple and efficient, and as capable of being practised upon every farm. About the beginning of October, or when the pastures or other green food fail in autumn, the horses are put on hard food, and receive a daily allowance of 20 lbs. of hay and 2 gallons of oats; or, in lieu of a portion of the oats, they may receive a night-feed of cooked roots, mixed with a little corn, and seasoned with salt; and both now and at subsequent periods, they should be fed three times in the day,—in the morning, at midday, and at night. In November, December, and January, they continue to receive the same allowance of oats, or of cooked food in lieu of a portion of the oats; but they are wholly deprived of their hay, and receive instead of it pease-straw, bean-straw, oat-straw, or chaff-cut wheat-straw. At the beginning of February, they begin again to receive their hay; from the commencement of the busy period of spring, or from oat seed-time till about the beginning of June, they receive a daily allowance of 3 gallons of oats, or a night-feed of cooked food in lieu of a portion of this allowance; and from the beginning of June till the beginning of October, they receive a daily allowance of only one gallon of oats, and otherwise are either fed entirely on cut green food, or are pastured during the night and fed on cut forage during the intervals of work in the day. In all dietetical treatment of farm-horses, whatever be the particular methods of it, and whatever the kinds and varieties of the food used, thorough care should be exercised to keep the animals in uniformly good condition,—never to allow them even slightly to fall off; for the partial loss of their labour during the period of recovering them from reduced condition, will, in every instance, amount to several times the value of all the food and shelter requisite to prevent a falling-off.

The Feeding of Cattle—Several principal points in the dietetic treatment of cattle, as to both food and shelter, have been the topics of violent conflict of opinion among practical agriculturists and stock-farmers. The use of the turnip is now so general and important, and has become so identified both with the general dietetic system of the farm and with the improved methods of tillage, fallowing, and rotation, that we might reasonably expect it to be the subject of a thoroughly considered and somewhat uniform opinion; yet this great topic in particular, and many other topics of cattle-diet in general, are either matter of controversy or matter of utter oversight, on the part of very distinguished agricultural writers. Mr. Brown, in his Rural Affairs, notices indeed the consumption of turnips by cattle and sheep, but does not discuss it; the author of the Complete Grazier writes minutely enough about yoking oxen, but does not show how they are to be either fed or fattened; the author of the Husbandry of Scotland discusses the comparative profits of feeding cattle and feeding sheep, yet strangely enough does not discuss the absolute manner of feeding either; Loudon, in his Encyclopedia of Agriculture, compresses into very brief space all he has to say respecting both the food and the housing of cattle; Culley says nothing whatever upon the use of the turnip or any of the details of dietetics; Lord Kames, Dr. Coventry, Loudon, Young, and others, widely disagree from one another respecting the quantity and the richness of food proper for young cattle; and most of the eminent practical writers, including Mill, Young, Doyle, Stephens, Marshall, and the writers of the agricultural reports on counties communicated to the Board of Agriculture, exhibit most perplexing contrarieties and discrepancies of opinion respecting a large proportion of the most important points of both the sheltering and the feeding of all kinds of cattle.

One cause of all this want of ascertained principle in cattle-dietetics has been inadvertence to the great object of winter-feeding,—the bringing of the cattle as speedily as possible to maturity, with a minimum of cost and a maximum of manure and of flesh; another cause has been great defectiveness in the condition of experiments,—such for example as should bring out nearly the same results from poor food and good shelter as from rich food and bad shelter, without any attempt to ascertain the proportion of the results due in either case to the influence of climate, temperature, ventilation, and litter; and a third cause has been ignorance of animal physiology and vegetable chemistry, or of the relation between the proportions of certain proximate principles in substances used as food and the production of flesh, fat, and general substance in the bodies of the animals fed. Great light has, within the last few years, been thrown upon the subject of the proper or economical feeding of cattle by the scientific investigations of Boussingault, Payen, Dumas, Liebig, Johnston, and other agricultural chemists; and whatever of this seems available in practice is exhibited in our articles FATTENING OF ANIMALS and FODDER, and in all those on the principal substances used either for food or for litter.

The differences of opinion of some of the most distinguished non-chemical agriculturists respecting the proper degree of nutritiousness in the food of cattle, are stated as follows by a writer in the second volume of the Quarterly Journal of Agriculture:—"Sir John Sinclair thinks that cattle may loathe too much rich food at a time; whereas Lord Kames says, that his instructions are intended to make cattle eat the greatest quantity possible. Dr. Coventry says, the quantity of good aliment necessary to fatten an animal when young, is found to be much greater than what would be sufficient to do this when it is more advanced in life; whereas Mr. Loudon observes, that 'in young growing animals, the powers of digestion are so great that they require less rich food than such as are of mature age;' and Mr. Young remarks, that, 'it is not right to keep yearling calves and two-year-olds together, because the younger the cattle are, the better they should be fed,' not because of the obvious reason, that the older would drive about the younger cattle. Dr. Coventry seems to consider the giving of rich food to young growing cattle, except for the purpose of improving the breed, as wasteful; and 'pampering,' as he terms early feeding, he says, 'prevents the whole animal from becoming course and large;' and Mr. Culley rejoices, 'that the small-boned, true-proportioned cattle are the very sort that produce more fine than coarse, that lay their fat upon the valuable parts, and always feed in much less time than the big-boned coarse set.' 'To produce the most perfect formed animal,' says Mr. Cline, 'abundant nourishment is necessary from the earliest period of its existence, until its growth is complete.'" The use which an intelligent farmer ought to make of these conflicts of opinion, is to exercise his own judgment, to attach doubtful weight to even the most confident assertions of theoretic observers, to acquaint himself well with the scientific principles of feeding, or with the connexions between the functions of cattle and the chemical properties of their food, and to appeal, for the solution of any difficulty or the obtaining of any information, far more to these principles than to the results of loose and general observations.

The best methods of feeding cattle, as to both their own health and the profit of their owners, are so powerfully modified by both the character of the farm and the nature of the breed, that a method quite excellent for one set of farms and breeds would be either absurd or altogether impracticable for another set. In this connexion, some remarks, in our articles CATTLE, BREEDING, and CROSSING, on the mutual adaptation of breeds and climates, ought to be well considered. A large proportion of cattle of the hardiest breeds, and a considerable proportion of those of the finer breeds, are reared to a certain point by farmers who have few other resources than those of mere pasture, and cannot profitably attempt the process of fattening, and are then sold to farmers who practise a system of mixed husbandry, and possess all the resources of shelter and food requisite to mature cattle for the shambles, and depend in a large degree for the profit of their farms upon the adroitery with which they make yearly transferences of stock, and the skill with which they subordinate the winter feeding of them to the economy of green fallows and to a far-sighted rotation of arable crops. The mountain cattle, when brought to their new quarters, are in many instances so lean and meagre, and sometimes so young, as not to be maturable for the butcher in a less time than twelve or even eighteen months; and, in such cases, they are usually fed during the first winter on straw or coarse meadow-hay, with a small allowance of green food, and are either grazed or soiled during the following summer, and are finally fed during the second winter with whatever available food is believed to be most suitable for fattening them. The cattle of better breeds, when reared on grass farms and transferred to mixed ones, are purchased by their second owners at various stages of age and maturity, and, for the most part, are fed, in their new quarters, only during a single winter, or at most till some time in the following summer.

But whether cattle are treated in this manner, or are fed to maturity and finally fattened where they are bred, the chief points of doubt or nicety, or questions of either importance or difficulty, as to their dietetical treatment, have reference to their winter-feeding. All other points are easily settled; and the principal of these, relating to the management of pastures, to the rearing and disposing of calves, to feeding with direct adaptation to the dairy, and to the practice of stall-feeding in summer as well as in winter, are discussed in our articles GRASS-LANDS, PASTURE, CALF, COW, DAIRY, and SOILING. Now the practical amount of all the sound principles involved in winter-feeding, is, as we already stated, to bring the cattle to the soonest possible maturity with a minimum of cost and a maximum of manure and of flesh; and just in the degree in which the results of any one method approach this amount, they prove that method to be good. "At whatever rate of rent a farmer holds his land," remarks the periodical writer formerly quoted, "it is very obviously for his interest as a matter of profit, to regulate the treatment of his cattle in winter, by the principle of bringing them as soon as possible to maturity, and of keeping them, after that period, as short a time as possible in his possession. This is a principle in economy which no one will be disposed to dispute; and it gives rise to many questions, such as, What breed of cattle comes soonest to maturity? What mode of treating the cattle themselves will bring them soonest to maturity? What rotation of cropping will command the greatest quantity of food for bringing cattle soonest to maturity? And under what system of husbandry, as affecting the reciprocal assistance which stock and crop afford each other, will cattle be brought soonest to maturity? These are all important questions in themselves; but the answers to them all form corollaries to the general principle, that the sooner cattle are brought to maturity, and disposed of, the more profitable they are to the farmer."

Several of the chief questions involved in this great principle are concentrated in the grand question of the kinds of food which best combine fattening power with general economy; and, being all intricate in themselves, they combine with the intricacies of vegetable chemistry and animal physiology and the mutual subservience of the two, to render tolerably good solutions of that grand question very numerous, and prime or very excellent solutions of it exceedingly difficult. So many as a dozen or a score of selections of food, or of the proportionings and alternations of some of the best alimentary substances, may very well combine the speedy fattening of cattle with generally economical results; and yet every one of them may, upon investigation, prove seriously faulty in comparative dearth, in deficient adaptation to rotations of cropping, in excess or under-quantity of some of the substances, or in wasteful disproportionateness of some of the chief proximate principles of nutrition. Again, therefore, must we hint the necessity of intelligent farmers making a vigorous use of their own judgment; and we must refer them to the articles already alluded to, and restrict ourselves here to two or three general remarks.

Coarse and comparatively innutritious food, such as straw even when chaff-cut, ought not to be used. Both vegetable chemistry and general economy will speedily demonstrate to a reflecting farmer, that all the straw available for cattle from a good system of rotation is most profitably employed in the way of litter. The number of cattle kept during any season upon a farm, ought to be rather an unit or two below than even a fraction above the par of existing provision for feeding them into good condition. Not only does deficiency in the supply of food, as compared with the number and wants of the cattle, prevent that acceleration of maturity which we have seen to be one grand aim of winter-feeding; but, in the case of the weakest and most timid of the animals, it may occasion half-starvation and eventual disease. "As some of the cattle have forward dispositions, they will certainly take the advantage of their more gentle neighbours, and deprive them of most of even their scanty supply. The fear which is continually upon the latter of being driven about, dejects their spirits, and exposes them to cold and wet, as well as hunger; hence, the origin of many pulmonary diseases among cattle." The supplies of food ought to be in measured quantities and at regular hours; and, even though considerable portions of former supplies should remain unconsumed, the fresh supplies ought to be given with the utmost punctuality, even to a minute. "Cattle know perfectly well when the time arrives for a fresh supply, even though the mangers in the hammels may not be empty, which they should never altogether be. When they are supplied with food at irregular times, they will either crave it, or become careless about it; and, from uneasiness arising from frequent disappointments, they will not feed so pleasantly and speedily as when their food is placed before them at exact periods." Cleanliness, a due degree of warmth, abundance of litter, pure air, precautions against epizootics, and other points of general treatment are, we hope, so obvious as not to require enforcement or illustration.

Cattle may be winter-fed either in houses or in courts and sheds. Those fed in houses are tied to stakes with chains or binders, and receive their supplies of food into permanent mangers; and those fed in courts and sheds may be variously accommodated, according to the particular structure and subdivisions of the farm-yard, but, in all favourable circumstances, do best in the very small courts and shelter-sheds provincially called **Hammels**. See the articles **Farm-Yard Buildings** and **Hammels**. Lord Kames strongly prefers house-feeding to hammel-feeding; but Sir John Sinclair prefers hammel-feeding to house-feeding; and many other eminent agriculturists also adopt opposite sides of this question. Yet when the climate is good, when the situation is well-sheltered, when the court is dry, when the litter is abundant, when, in short, the conditions are present for constantly securing the requisite degree of warmth and cleanliness, the great majority of the present race of intelligent agriculturists appear to be firmly on the side of the hammels. "In these, the cattle are at perfect liberty to roam about, if disposed for exercise; they are exposed to all the sunshine there may be in a winter day, and the very rain which falls on their backs titillates the skin, and causes them to lick and clean themselves; they are comfortably warm in their shed among an abundance of straw in the coarsest night, and cattle will never suffer from cold when they have a comfortable shelter to which they can repair at will; they can come and go to their food whenever they please, night and day, and their meat being constantly in the open air, it will be always fresh and sweet; and their feet and hair, when they come to travel, are quite able to bear the hardness of the road and the coldness of the air." A trial of the comparative merits of hammel-feeding and house-feeding, conducted by John Boswell, Esq., of Kingcausie, and reported in the Transactions of the Highland Society, exhibits the following results:—"Four two-year-old oxen of aggregately 40 cwt. 7 lbs. in weight, fed in hammels from 17th October till 19th February, consumed 27 tons 1 qr. 1 lb. of turnips, and acquired a weight of 5 cwt. 2 qrs. 22 lbs.; and four two-year-old oxen of aggregately 39 cwt. 2 qrs. 7 lbs. in weight, fed in houses during the same period, consumed 25 tons 12 cwt. 2 qrs. 23 lbs. of turnips, and acquired a weight of 4 cwt. 7 lbs.; and the clear money-gain in favour of the hammel-fed oxen, estimating the turnips at 20s. per ton and the carcase at 48s. per cwt., and after allowing for the surplus-quantity of turnips consumed in the hammels, was £2 18s. 2¾d., or 14s. 6½d. per ox. Also, four three-year-old oxen, of aggregately 43 cwt. 3 qrs. in weight, fed in hammels from the 28th of October till the 28th of February, consumed 22 tons 17 cwt. of turnips, and acquired a weight of 5 cwt. 3 qrs.; and four three-year-old oxen, of aggregately 42 cwt. 3 qrs. in weight, fed in houses during the same period, consumed 20 tons 12 cwt. 6 lbs. of turnips, and acquired a weight of 4 cwt. 2 qrs.; and the clear money-gain in favour of the hammel-fed oxen, estimating the value of turnips and carcase at the same amount as in the preceding experiment, and after making allowance for the surplus-quantity of turnips consumed in the hammels, was £1 17s. 6d., or 9s. 4½d. per ox.

The Feeding of Sheep.—The treatment of sheep in accordance with difference of climate and of breeds, is glanced at in the articles **Breeding** and **Crossing**; the treatment of them in accordance with differences of farms and of husbandry, as on mountain sheep-farms, on low country grass-farms, on farms of the mixed husbandry where they are constantly kept, and on farms of the mixed husbandry where they are kept principally at intervals or during a mere portion of the year, will be noticed in the article **Sheep**; and particular matters as to the proper treatment of respectively their males, their females, and their young, are stated in the articles Ram, Ewe, and Lamb. We shall, in this place, notice only the usual method of winter-feeding the general sheep stock on first-class farms of the mixed husbandry.

In the latter part of October, or when the pastures cease to yield sufficient food, the flock begin to be fed with turnips, either by having them brought to the pasture-fields, or by being folded upon them in the fallow-fields where they have grown. Both the place and the manner of consuming the turnips may be determined partly by reference to differences of effect upon the sheep themselves, but in practice are always determined chiefly and often wholly by reference to the manuring effects of their droppings and the contact of their bodies upon the soil; and the method by folding is one of the most powerful manuring forces in a good rotational series of crops, and is often modified, as to the amount of turnips consumed on the spot, whether the whole or only a part, by reference to the particular degree of fertilization which the state of the land requires. See the articles Turnip and Rotation. When the sheep are folded, they are usually confined by means of wooden hurdles, vertical nets, or other temporary fences, to a space which will serve them for a week or for some similarly limited period; when they have eaten the turnips in this space close to the ground, the lower parts of the bulbs are hoed out of the ground for their use; and when they have consumed these, they are admitted, by a shifting of the fences, to another section of the field. But they ought, in every case, to be constantly supplied also with a portion of hay, placed within the temporary enclosure, in moveable racks so constructed as to keep the hay from the ground, to shelter it from the rain, and to allow it to be freely extracted by the sheep from the sides. Young sheep, when folded upon turnips through the winter, sometimes experience serious injury to their teeth before spring; and all such ought to be removed to a grass field with firm dry sward, and there fed with turnips prepared for them by the turnip-slicing machine. Toward the end of March or in the early part of April, as soon as the pasture-grasses are sufficiently up to afford matter for the close short bite of sheep, the whole flock are turned upon the pastures; but should the turnips be exhausted before the pastures are ready, all the young ought, at whatever cost, and in order to prevent them from ruinously losing condition, to be fed on hay, on oats, or on whatever suitable food the farmer can demand.—*Quarterly Journal of Agriculture,—Napier's Treatise on Store-Farming.—Transactions of the Highland Society.—Journal of the Royal Agricultural Society of England.—Boussingault's Rural Economy.—Hunter's Georgical Essays.—Doyle.—Stephens.—Lowe.—Loudon.—Young.—Sinclair.—Blaine.—Youatt.—White.*

FEELING. One of the five external senses, by which we obtain the ideas of solid, hard, soft, rough, hot, cold, wet, dry, and other tangible qualities. It is the most universal of all the senses. We see and hear with small portions of our bodies, but we feel with all. Nature has bestowed that general sensation wherever there are nerves, and they are everywhere, where there is life. Were it otherwise, the parts divested of it might be destroyed without our knowledge. It seems that, upon this account, nature has provided that this sensation should not require a particular organization. The structure of the nervous papillæ is not absolutely necessary to it. The lips of a fresh wound, the periosteum, and the tendons, when uncovered, are extremely sensible without them. These nervous extremities serve only to the perfection of feeling, and to diversify sensation. Like every other sense, feeling is capable of the greatest improvement: thus we see that persons, born without arms, acquire the nicest feeling in their toes; and, in blind people, this sense becomes so much developed, that individuals born blind, and acquiring the faculty of sight in after life, for a long time depend rather on their feeling than on their sight, because they receive clearer ideas through the former sense. A person in this condition, who could not remember the difference of things, if he only saw them, as soon as he touched them, distinguished them perfectly well. Feeling is the most common of all the senses, as it exists in all creatures, which have any sense at all; even some plants show a sensibility to touch. Many animals have no sense but that of feeling.

FEET. See Foot.

FELDSPAR. See Felspar.

FELL. The hide of a beast. A fellmonger is a person who dresses or sells hides. Fellmongers' clippings, consisting of the parings and scrapings of hides, are usually employed in the manufacture of glue, but have in many instances been employed as manure, and are powerful fertilizers.

FELLING. The cutting down of trees. The common methods of felling are simply to hew with the axe, to cut with the cross-cutting saw, or to alternate or combine the action of these two instruments. But a superior method, in the case at least of all large, straight, and valuable trees, is to employ the saw, and to combine with its action the use of a wedge. "In order to make the tree fall the way required, enter the cross-cut saw on that side of the tree it is intended to fall, and cut it about a third-part through; then enter the saw at the other side, and, when it is cut so far as to admit a wedge, place the wedge exactly opposite the way you want the tree to fall, and keep driving it slowly till the tree is nearly cut through. Be sure the saw meets the opposite cut equally on both sides; and do not imagine, as some have done, that by making the saw meet sooner through the one side than the other, the tree will fall to the side soonest met or first cut through; on the contrary, the side of the tree longest in being cut is that side to which the tree will naturally fall."—[Monteath's Forester's Guide.]

Every tree, in being felled, ought, for the sake of the value of the timber, and also for other considerations, to be cut as near as possible to the ground. Buffon recommends that trees intended to be felled should be deprived of their bark and allowed to stand, and harden, and almost die before being cut; and he alleges that, by this means, the alburnum becomes as hard as the duramen, and the density and strength of the entire timber are increased. But when the alburnum happens to be of little or no value, any method of caring for it is superfluous; and when it happens to be of consequence, it naturally possesses, about the time of mid-winter, all the consistency of the duramen, or rather has then ceased to exist and has become identified with the outer layer of the duramen, so that, at that time, any tree may be economically felled without any preparatory barking. All young trees and all constitutionally soft trees, in fact, ought to be felled about mid-winter, when little or no alburnum exists; and all old and constitutionally hard trees may, generally speaking, be economically felled at almost any time of the year.

A tree about to be felled ought to be carefully divested of any arm or branch which may be at all likely to occasion damage to it in its fall. Any very large bough should be chopped or nicked one-third through close to its junction with the trunk, by strokes of the axe below; and if then struck with a few down-right strokes on the upper side, it will be severed without splitting. A clear space for the fall of the tree should be selected,—such as will prevent it from damaging other trees or from injuring shrubs, fences, or other objects by its fall; and the felling process should be so performed as to make the tree descend through this space. Careless foresters, in consequence of taking insufficient precaution to guide the fall, or of hewing into the stem without due reference to the proper point of upsetting the equilibrium, often perpetrate very serious and costly damage. A common precaution in the case of any considerable tree in a somewhat crowded situation, is to attach ropes to its upper parts by means of climbing-boys or of a ladder, and to have the ropes pulled by one or more assistants in the direction in which the tree is intended to fall; and this precaution may be facilitated, some time saved, and the risk of accident in using the ladder avoided, by means of a simple invention of Mr. Borthwick of Crookston, consisting of a hook of 6 or 8 inches in span, a ring at one side of it for the attachment of of the rope, and a moveable shaft of 16 or 18 feet in length for placing the hook upon the tree.

Several felling saws have been invented, for cutting through the trunk with ease and expedition, and preventing the loss of timber which results from chopping with the axe; but they have not been found sufficiently suitable to recommend themselves to foresters. One, invented by Mr. Jack of Craigdallie in Perthshire, is on the circular principle, and has gearing which brings the saw forward as the cutting proceeds, and is mounted on a bed-frame by which, as if on a hand-barrow, it can be readily carried from tree to tree. Another, invented by Mr. Vallance of Libberton in Lanarkshire, cuts on the reciprocating principle, and is worked and carried forward during the cutting-process by a lever. Another, invented by Mr. Gordon of Aberdeen, is on the circular principle, but has a different arrangement from Mr. Jack's, and is deficient in the feed and in the means of conveyance.

The stump or stool of a tree is the part which remains in the ground after felling; and this, in some instances, dies away,—in others, makes shoots which can be coaxed up into new trees,—and in others, is grubbed up or otherwise artificially destroyed, to make way for the passage of the plough. The stools of some trees, such as those of many of the pine tribe, never send out shoots; and the stools of others, such as those of oaks and ash-trees, readily send out each from ten to twenty shoots. Stools which do not shoot might be thought to serve by their decomposition as masses of manurial matter, or as great seats of future humus, amidst the piece of circumjacent soil; but they attract great multitudes of insects, and form a platform for innumerable fungi, and, in consequence, have a pernicious rather than a fertilizing action. Stools which form shoots do not extend or renew their radical elongations, but develop a sort of lip around the border of their upper surface in the same manner as branches which have been cut asunder in pruning, and send out their new shoots from buds near the section. The manner of treating these shoots, with a view to either coppice-wood or trees, is noticed in the article Coppice. Some foresters recommend that stools designed for coppice-shoots should be dressed into an uniform, sloping surface with the adze; but this operation really seems to be of little or no use.

When the trees are of such a kind as not to leave shooting stools, or when the ground is intended to be cleared for the plough, or probably in all cases except for the continuance of coppices, the most economical method of bringing down trees, is not to fell them at all, but to grub them up, or to detach the body of the root from the remote radical ramifications, and let it continue a part of the uptorn tree. The expense of this method, no matter how operose, will generally be found less than that of the subsequent grubbing up of the stools; and it possesses the twofold advantage of preventing the segregation of insects and fungi, and rendering the fresh wood of the root available as timber. The knotted, gnarled, contorted structure of the root, with the stumps of its ramifications, renders it peculiarly suitable for ornamental rustic work; and the compactness of its timber, with the grotesque irregularity of its concentric layers, and the fantastic arrangement of its medullary rays, renders it, in many instances, eminently fitted for both the curious and the useful works of the cabinet-maker.—*Monteath's Forester's Guide*—*Watson's Forester's Manual*.—*Knowledge Society's Useful and Ornamental Planting*.—*Keith's Botanical Lexicon*.—*Transactions of the Highland Society*.—*Catalogue of the Highland Society's Museum*.—*Society of Gentlemen's Complete Farmer.*

FELLING-SAW. See Felling.

FELLMONGER. See Fell.

FELLOE. See Cart and Wheel.

FELLON, or Felon. A disease in cattle, commencing with symptoms closely akin to those of catarrh, but becoming complicated with symptoms similar to those of rheumatism. It generally arises from sudden exposure to the weather in spring, after housing and a course of poor feeding throughout the winter. It commences sometimes with an acute chill, and sometimes in the manner of a common cold; it appears for a time like a common catarrh, accompanied with a comparatively high degree of fever; and it soon develops symptoms of stiffness and pain, first in the back, and next in the joints of the limbs. When arrested in the stage of stiffness and pain in the back, it is sometimes called chine-fellon; and when it takes its full course, it occasions swelling in the joints, and is generally called joint-fellon. Treatment for it in its earlier stages ought to be strictly similar to that for catarrh; and treatment for it in its fully developed state, ought to include the use of embrocations similar to those which are proper for rheumatism. See the articles Catarrh and Rheumatism.

FELON. See Fellon.

FELSPAR, or Feldspar. A name in mineralogy, under which has been comprehended a great variety of substances, hitherto believed to form a single species, but which the researches of modern mineralogists prove to constitute several distinct species. The inquiries upon which the proposed distinctions depend, however, being among the nicest in the science, cannot, consistently with the general plan of this work, be noticed here. We shall rather confine our remarks to that portion of the contents of the old species of felspar, in which, from its wide distribution and known applications, mankind are more generally interested.

Its crystals and crystalline masses yield to cleavage parallel to the planes of a doubly oblique prism, which presents, by the reflective goniometer, in one direction, four angles of 90°; in another, four, alternately of 59° 25′ and 120° 35′; in another, four, alternately of 67° 15′ and 112° 45′—the two cleavages, which are perpendicular to each other, being obtained with the greatest facility, while the third is effected with much difficulty. One of the perpendicular cleavages is effected with greater ease than the other, indications of which are always apparent in delicate, parallel lines upon the faces produced by the less distinct cleavage. The general figure of the numerous crystals of felspar is an oblique prism, with unequally produced planes, whose number varies from four to ten. These prisms are terminated by summits, composed, ordinarily, of two large, culminating faces, and several smaller faces, which seem to obey no constant law of arrangement. Hence it results, that the forms of felspar are among the most dificult to understand and describe of those found in any species in mineralogy. The following may be instanced as the simplest of those ordinarily met with, viz., an oblique prism with four faces (*Felspath unitaire*, H.); a prism with 10 faces, six broad and four narrow, terminated at each extremity by two broad culminating faces (*F. quadridécimal*, H.); an oblique rhombic prism (oblique from the obtuse edge), having its acute lateral edges truncated, and terminated by a single plane at each extremity (*F. prismatique*, H.); the same as the last, but terminated at each extremity by summits of five faces, disposed without symmetry (*F. sexdécimal*, H.) The lustre of felspar is vitreous, sometimes inclining to pearly, upon the perfect faces of cleavage; prevailing colour white, inclining to grey or red; sometimes grey, flesh red, and rarely verdigris green; translucent, and sometimes transparent, and occasionally offers a bluish opalescence in certain directions; hardness below quartz, but not scratched by the knife; specific gravity from 2.53 to 2.60. It is not common to find felspar in distinct crystals. Its more usual mode of occurrence is in broad, foliated masses, variously disseminated among other minerals. Rarely it occurs in granular concretions; and, occasionally, it is quite compact. Before the blowpipe, upon charcoal, it becomes glassy, semitransparent and white, but melts only with difficulty, on its edges, into a semi-transparent vesicular glass. A crystallized specimen, analyzed by Vauquelin, gave 64 per cent. of silica, 20 of alumina, 24 of potash, and 2 of lime; and felspar, in its general or average occurrence in rocks, is stated by Liebig to consist of 65.9 per cent. of silica, 17.8 of alumina, and 16.3 of potash.

Felspar is the most generally diffused, both as to its local and geological situation, of all minerals, with perhaps the exception of quartz. It is an essential constituent of granite and gneiss, and frequently occurs in micaceous and argillaceous slate. It is contained abundantly in almost all porphyries, in which it sometimes exists in large imbedded crystals. It abounds in primitive and secondary greenstone, the traps and trachytes, forms a large part of lavas, and has even been recognised as an ingredient in many meteoric stones. It is occasionally, though rarely, found in veins, or beds, in primitive limestone; and though, when occurring along with quartz and mica, in the primitive rocks, it is most generally disseminated, yet it frequently forms concretions separated from those ingredients, assuming the shape of more or less extended, irregular beds. If these be decomposed, by the action of the air, beds of porcelain earth are formed, the most remarkable of which are those in gneiss, at Aue, near Schneeberg, in Saxony, and at Hafnerzell in the district of Passau. Similar deposits occur near Limoges in France, and in Cornwall in England. Localities of it are known in the United States, and in China, where it is called *kaolin*.

Several varieties of felspar are used in the arts and manufactures. 1. The transparent, opalescent variety, from Ceylon and St. Gothard, (commonly called *adularia*,) is much esteemed in jewelry. When cut *en cabochon*, it reflects, from its interior, a pearly, white light, which floats from one part of its surface to another, according as we vary its position; from which circumstance it is called the *moon-stone*, or *fish's-eye-stone*. It is often mounted in the centre of a circle of diamonds, whose sparkling reflections contrast in a beautiful manner with the silvery light hovering over the moon-stone. 2. The verdigris-green variety, called the *amazon-stone*, which comes from near Ekaterinburg, in Russia, and which has also been found in small quantity at Beverly, in Massachusetts, is likewise much esteemed by the lapidary. 3. A third variety of this species, employed in jewelry, is the avanturine felspar, which comes from the island of Cedlovatoi, near Archangel, and which is of a honey-yellow colour, and everywhere penetrated by little golden spangles. 4. The pure varieties of felspar are used in the composition of the paste of porcelain; also for the enamel with which it is covered; and the decomposed variety, or porcelain earth itself, is the most important material in that department of manufactures. The great abundance of felspar in many rocks, particularly in the traps, basalts, greenstones, porphyries, and granites, and the fine proportions in which it combines silica, alumina, and potash, render soils which largely consist of the disintegrations of felspathic rocks specially interesting to scientific agriculturists and valuable to practical farmers. See the articles ALUMINA, CLAY, POTASH, SILICA, and SOILS.

FELSPATHIC ROCKS. See FELSPAR.

FELWORT,—botanically *Swertia*. A genus of plants, of the gentian tribe. The perennial felwort, *Swertia perennis*, is a herbaceous, perennial-rooted aquatic of the mountain marshes of England. Its roots are fibrous, long, cylindrical, whitish, and exceedingly bitter; its stem is quadrangular, erect, and about a foot in height; its leaves are petiolate, acute-ovate, and from one inch to two inches in length; and its flowers grow in panicles, on angular peduncles, have a purplish colour and handsome appearance, and bloom in July and August. A hardy annual species has been introduced to British flower-gardens from Siberia, and a hardy biennial from North America; and upwards of a dozen other species are known.

FEN. A low and flat expanse of alluvial land. Some fens are marine alluviums, more or less in the condition of salt marshes; some are marine alluviums, accumulated by artificial aid; some are marine alluviums, reclaimed from the dominion of the waters by elaborate processes of embanking and draining; and some are lacustrine and fluviatile alluviums, partly consisting of the originally deposited silts, but chiefly formed through the intermediate condition of bogs and marshes, and the subsequent operations of draining and reclamation. The salt marsh fens are rarely of any considerable extent, and are very generally used as grass lands or marsh meadows. See the article MARSH. The fens formed by marine depositions with artificial aid, are low tracts upon the margins of tidal rivers, so situated as to have allowed, by means of sluices, the letting in and shutting out of silt-depositing tides. See the article WARPING. The fens reclaimed from the dominion of the sea by means of embanking and draining, are of great extent and various character; they comprise a large aggregate of excellent land on the south-west coasts of England; and they are maintained in a state of proper drainage, and in some places from the irruption of the tides, by extensive and costly works somewhat akin in general character to those which defend the vast kindred marine alluviums of Holland. See the article DRAINING. The fens of lacustrine and fluviatile origin constitute the vast rich plain of the Bedford Level, which extends through six counties on the east side of England, and is by far the largest and most valuable plain in Great Britain. A great portion of this plain is well drained, has a fine soil, is in good cultivation, and produces excellent crops; another portion has a light soil and a peaty subsoil, and cannot without much cost and effort be properly drained and well cultivated; and a third portion lies somewhat higher than the rest, has a very light soil, and is more suitable for pasturage than for the plough. The marine fens generally abound in saline plants, which are very healthful for cattle; and some parts of the lacustrine fens contain within their substrata abundant deposits of rich and fertilizing marl.

FEN. A disease of growing hop-plants. It consists in the rapid, spreading, and smothering growth of some minute parasitic cryptogams; and it sometimes works fearful havoc upon the hop crops. See the article HOPS.

FENCE. The defensive-work of an enclosure; or a protection of any kind round a garden, a field, a park, a forest, or any other defined and separated piece of land. The subdivision of territories and estates by means of fences is discussed in the article ENCLOSURE; and the respective kinds of fences, together with the methods of severally constructing and maintaining them, are noticed in the articles HEDGE, DITCH, EMBANKMENT, WALL, HA-HA, and PALING. The properties and adaptations of some of the principal materials used for hedges, too, are noticed in the articles **Hawthorn**, **Holly**, **Hornbeam**, **Furze**, **Elder**, **Beech**, **Barberry**, **Yew**, **Privet**, and **Briar**. Some of the varieties of fence which differ most widely from one another in character, and are respectively adapted to widely different purposes and situations, are the close live fence round rich farm fields, the dry stone wall and the turf or the earthen wall along the divisions of moors and mountain pastures, the simple but deep ditch round the fields of a low alluvial farm, compounds of hedge and wall, or of ditch and embankment, or of wall and paling, or of wall, hedge, and ditch round peculiarly exposed enclosures, the ha-ha or sunk fence along the subdivisions of ornamental grounds, and the park-paling or the lofty and massive wall round the limits of a landowner's park or home-grounds.

The fences of a farm, technically considered, comprise not only the hedges, walls, ditches, or other defensive works along the subdivisions and round the limits of the farm, but also the gates, the stiles, and the bridges which intersect these works. All ought to be in good condition when a tenant takes possession of his farm; and all ought to be so maintained by him as to be left in an equally good condition at the expiration of his lease. A tenant who, simply of his own choice, constructs any fences during the time of his possession, is understood to be consulting only his own convenience, without any controlling reference to his landlord's interest, and is not entitled to ask any compensation for his outlay in constructing them; but when he undertakes them after consultation with his landlord or his landlord's agent, and with his express concurrence, he receives whatever assistance or compensation he can obtain by agreement. Some landlords remove old fences and construct new ones entirely at their own cost, and rear, clean, and protect the latter during six or eight years, and then surrender them to be wholly maintained by the tenant; some supply plants or paling-wood for mending the gaps of old hedges; and some provide all the materials for new hedges or other fences, and impose on the tenant the labour or cost of constructing them. But many landlords are grossly inattentive to the true interests of their estates, as to the maintenance of all the fences in a thoroughly efficient condition; and almost all tenants look only to results during the period of their own tenancy, and evade all attention to fences beyond what is necessary for their own immediate advantage. The consequence is, that multitudes of fences throughout entire districts of country, are an absolute disgrace to the high agricultural character of the kingdom. "By almost universal practice," remarks Bayldon, "hedges are planted, and little more heeded. The fence is thus neglected and becomes a bad one, and forms a never-failing source of disputes and valuations for repairs between the out-going and in-coming tenant. To this cause must be attributed, not only the shameful condition, but the utter ruin, of fences all over the kingdom. If the soil and situation be favourable, they grow and become a fence by chance; but they owe very little to the care of any person. In cases of such neglect, the original outlay is greatly lost; for in a short time, another expenditure is required to uphold it, which might have been partly prevented. Boundary fences between farms and estates are generally in the worst condition; it might be attended with benefit to divide them equally between the respective tenants. On these points, there is a very wide field for improvements in every part of the kingdom. It must be effected by the land-owners."

FENNEL. Several species of medicinal and culinary herbaceous plants, of the anethum or dill genus and umbelliferous order.

The common fennel, *Anethum fœniculum*, but called by some botanists *Meum fœniculum*, is a hardy herb, usually called a biennial, but readily prolonging itself so as to be really a perennial. It was introduced to Britain from the south of Europe, but has become so naturalized on some of the chalky cliffs and pastures of England as to be commonly classed with our truly indigenous plants. Its root is fusiform; its stem is erect, smooth, striated, leafy, branching, and usually about 5 or 6 feet in height; its leaves are alternate, triply pinnate, and deep glaucous green; its leaflets are smooth, long, linear, and drooping; its flowers grow in large, terminal, flat, many-rayed umbels, have a yellow colour, and bloom in July and August; and its seeds are ovate, three-ribbed, and brownish-olive-coloured, and have a fragrant odour, a warm aromatic taste, and gently carminative properties. This plant may be raised either from seeds or from offsets; and it is much cultivated in first-rate kitchen-gardens, and occasionally in second-rate ones, as a culinary aromatic herb. It is commonly employed as a garnish; but its leaves also are eaten with fish, its seeds are used as a carminative, and its root is used as a carminative and a tonic.

The sweet fennel, *Anethum fœniculum dulce*, is usually esteemed a mere variety of the common fennel, yet possesses distinct and somewhat different characters. It was introduced from Italy, but has long been cultivated in our kitchen-gardens. Its stem is somewhat compressed at the base, and usually has a height of only about 4 feet; its lower leaves are distichous; its leaflets are linear, hair-like, and very long; its umbels have only six or eight rays; and its seeds are much longer and somewhat paler than those of the common fennel, and have a sweetish as well as aromatic flavour. This plant is used for the same purposes as the common fennel; but its seeds are mainly in request, and have long been imported in considerable quantity from Italy, and used in the preparation of a volatile oil and an officinal fennel water of the drug shops. The volatile oil seems to contain nearly all, if not absolutely all, the virtue of the seeds; but it has been proved by much experience to be nothing superior to the oils of anise and caraway as a carminative; so that fennel is now much less in request than at a former period.

Azorean fennel, French fennel, or finochio, *Anethum segetum*, is a hardy annual, and was introduced to Britain about half a century ago from Portugal. Both this plant and the sweet fennel are much relished as salad herbs and pot herbs in Italy and Portugal; but French fennel is too powerful in its odour to be generally agreeable to Britons, and is used only by gourmands and a few other persons of curious palate. Its stems are fleshy, tender, nearly two inches thick, and usually about 6 or 8 inches high; and they are the part eaten,—and are either sliced in soups or for salads, or are blanched and eaten with oil, vinegar, and pepper. The seeds have a bright yellow colour, are narrower and more crooked than those of the common fennel, and have a strong smell similar to that of anise seeds.

FENNEL (Hog's). See Sulphurwort.

FENNEL-FLOWER, or Devil-in-a-Bush,—botanically *Nigella*. A genus of hardy, ornamental, annual plants, of the ranunculus order. Ten or eleven species have been introduced to Britain, principally from the shores of the Levant, and are usually cultivated among the annual beauties of our flower borders. Two or three of the species grow wild in the corn-fields of Continental Europe, and are not much esteemed as flowering-plants; but all the others are in more or less favour among the cultivators of the finest annuals. Their flowers are curious as well as beautiful, and grow at the top of the stems, beneath the shelter of large, leafy, divided involucres, and usually bloom from June till September. The flowers of three of the species are yellow; of three, are pale blue; of four, are blue and white; and of the rest, are principally lilac and blue. The plants are very shy of transplanting, but otherwise require no nicety, and readily sow and propagate themselves.

FENUGREEK,—botanically *Trigonella*. A genus of herbaceous plants, of the lotus division of the leguminous order. The common species, *Trigonella Fœnumgræcum*, was introduced to Britain from the south of France near the close of the 16th century. It is a hardy annual. Its stem is hollow, branching, and about two feet high; its leaves are alternate and trifoliate,—so as to occasion it to be often regarded as a trefoil; its folioles are oblong, oval, and indented; its flowers come out singly at each joint from the wings of the stalk, are sessile, and bloom from June till August; its legumes are elongated, flattened, and sharp-beaked, and have a broad membrane along one edge; and its seeds are yellow, square, and indented on one side. The whole plant has a very strong odour. The species has long been cultivated in the fields in Germany and the south of France; and it has, at various times, been recommended to the attention of British farmers; but it has never as yet won any considerable degree of British favour. Large quantities of imported seeds of it have often been in request; but the plant itself has always proved a very uncertain and even critical crop under the changeable weather and early frosts of our climate. In cold wet seasons, plants of it in British fields or gardens are frequently killed before the seeds ripen; and such as live long enough to perfect their seeds, suffer great and permanent injury to the pods during the process of ripening. The best soil for them is a light hazel loam, not enriched with manure; the best time of sowing is the beginning of September; and the most suitable culture is similar to that for autumn-sown pease. The plants become ripe in the following August; and they should then be cut down, laid out for five or six days to dry, twice or thrice turned during that period, and finally thrashed in the field or housed in the yard in the same manner as pease. The seeds of fenugreek, in consequence of their mucilaginous properties, were formerly much used by farriers for making poultices and emollient glysters; and they were also given internally under pretence of some medicinal action, but really in downright quackery.

The prostrate and the sword species, are hardy trailing annuals, with flowers and pods similar to those of the common species. Two blue-flowered and four or five yellow-flowered species are hardy upright annuals, principally ornamental, very similar to melilots, and with bunched or umbellate flowers, and long-beaked ovate legumes. The Russian species, *Trigonella ruthenica*, is a hardy, trailing, perennial-rooted herb, with yellow, umbellate, foot-stalked flowers, netted and compressed legumes, and stems of about 20 inches in length; and is propagated either from seeds or by the dividing of the roots. The small-horned species, *Trigonella corniculata*, is a low, fragrant, yellow-flowered, hardy annual. The esculent species, *Trigonella esculenta*, is an annual of nearly two feet in height, cultivated in the fields in India, but fit only for the hothouse in Britain. Upwards of twenty other species have been introduced to our gardens or botanical collections; and nearly as many more have been scientifically described.

FENZLIA. A genus of recently discovered ornamental plants, of the polemonium tribe. The carnation-flowered species, *Fenzlia dianthiflora*, is a low hardy annual; and was brought about twelve years ago from California. Its stem is 3 or 4 inches high; its leaves are opposite, entire, and linear; and its flowers grow on foot-stalks, are about an inch in length, and combine purplishness in their upper part with yellowness in their lower part.

FERMENT. See Yeast.

FERMENTATION. The spontaneous changes which vegetable matter undergoes when exposed to ordinary atmospherical temperature. So long as vegetable substances remain in connexion with the living plants by which they were produced, the tendency of their elements to form new combinations is controlled; but, as soon as the vital principle is extinct, they become subject to the unrestrained influence of chemical affinity. Owing to the difference in the constitution of different vegetable compounds, however, they are not all equally prone to fermentation; nor is the nature of the change the same in all of them. Thus alcohol, oxalic, acetic and benzoic acids, may be kept indefinitely without alteration; while others, such as gluten, sugar, starch, and mucilaginous substances are very liable to decomposition. In like manner, the spontaneous change sometimes terminates in the formation of sugar; at another time, in that of alcohol; at a third, in that of acetic acid; and, at a fourth, in the total dissolution of the substance. This has led to the division of the fermentative processes into four distinct kinds, viz., the *saccharine*, the *vinous*, the *acetous*, and the *putrefactive* fermentation.

The only substance known to undergo the saccharine fermentation is starch. When this substance is kept moist for a considerable length of time, a change gradually ensues, and a quantity of sugar equal to about half the weight of the starch employed is generated. Exposure to the atmosphere is not necessary to this change, though the quantity of sugar is increased by the access of air.

The conditions requisite for establishing the vinous fermentation are the following, viz., the presence of sugar, water, yeast, and a certain temperature. To observe the chemical changes which occur, we must dissolve five parts of sugar in about twenty of water, adding a little yeast, and, introducing the mixture into a glass flask, furnished with a bent tube, the extremity of which opens under an inverted jar full of water or mercury, apply a temperature of 60° or 70° Fahr., to the materials. In a short time, we shall observe the syrup to become muddy, and a multitude of air bubbles to form around the ferment; these unite, and, attaching themselves to particles of the yeast, rise along with it to the surface, forming a stratum of froth. The yeasty matter will then disengage itself from the air, fall to the bottom of the vessel, to acquire buoyancy a second time, and so on. The fermentation will continue for two or three days, when it will terminate, leaving the impurities to subside, and the liquor clear and transparent. The only appreciable changes which are found to have occurred during the process, are the disappearance of the sugar, and the formation of alcohol which remains in the flask, and of carbonic acid which is collected in the inverted jar. The yeast appears to have operated only by bringing on the fermentation, without further contributing to the products. The atmospheric air, having been excluded by the nature of the apparatus, can have exercised no effect upon the result. The true theory of the process is founded on the fact, that the sugar, which disappears, is almost precisely equal to the united weights of the alcohol and carbonic acid; and hence the former is supposed to be resolved, during the process, into the two latter. Though a solution of pure sugar is not susceptible of the vinous fermentation, without being mixed with yeast, yet the saccharine juices of plants do not require the addition of that substance; or, in other words, they contain some principle, which, like yeast, excites the fermentative process. Thus the juice of the grape, of the apple, &c., ferments spontaneously, but not without enjoying access to the air; from which it would appear, that it must contain a principle which is convertible into yeast, or, at least, into a compound, which acquires the characteristic property of that substance, by absorbing oxygen. The various kinds of stimulating fluids, prepared by means of the vinous fermentation, are divisible into wines, which are formed from the juices of saccharine fruits, and the various kinds of ale and beer produced from a decoction of the nutritive grains previously malted. The juice of the grape is superior, for the purpose of making wine, to that of all other fruits, not merely in containing a larger proportion of saccharine matter, since this deficiency may be supplied artificially, but in the nature of its acid. The chief or only acidulous principle of the mature grape, ripened in a warm climate, such as Spain, Portugal, or Madeira, is the bitartrate of potash. As this salt is insoluble in alcohol, the greater part of it is deposited during the vinous fermentation; and an additional quantity subsides, constituting the *crust*, during the progress of wine towards its point of highest perfection. The juices of other fruits, on the contrary, such as the gooseberry or currant, contain the malic or citric acids, which are soluble both in water and alcohol, and of which, therefore, they can never be deprived. Consequently, these wines are only rendered palatable by the presence of free sugar, which conceals the taste of the acid; and hence it is necessary to arrest the progress of the fermentation long before the whole of the saccharine matter is consumed. For the same reason, these wines do not admit of being long kept; for as soon as the free sugar is converted into alcohol, by the slow fermentative process, which may be retarded by the addition of brandy, but cannot be prevented, the liquor acquires a strong, sour taste. Ale and beer differ from wines, in containing a large quantity of mucilaginous and extractive matters, derived from the malt with which they are made. From the presence of these substances, they always contain a free acid, and are greatly disposed to pass into the acetous fermentation. The sour taste is concealed partly by free sugar, and partly by the bitter flavour of the hop, the presence of which diminishes the tendency to the formation of an acid. The fermentative process, which takes place in dough mixed with yeast, and on which depends the formation of good bread, has been supposed, by some, to be of a peculiar kind, and accordingly designated by the name of the *panary fermentation*. More recent researches upon this subject, however, leave little doubt that the phenomena are to be ascribed to the saccharine matter of the flour undergoing the vinous fermentation, by which it is resolved into alcohol and carbonic acid See the article BREAD.

When any liquid has undergone the vinous fermentation, or even pure alcohol, diluted with water, is mixed with yeast, and exposed in a warm place to the open air, the acetous fermentation takes place. This change is attended with an intestine movement, and the development of heat and carbonic acid gas; the fluid, at the same time, becoming turbid, from the deposition of a peculiar filamentous matter. This process goes on tardily below 60° Fahr..; at 50°, is very sluggish; and at 32°, is wholly arrested. On the contrary, when the temperature is as high as 80°, it proceeds with vigour. It is necessary to distinguish between the mere formation of acetic acid, and the acetous fermentation. Most vegetable substances yield acetic acid, when they undergo spontaneous decomposition; and inferior kinds of ale and beer are known to acquire acidity in a short time, even when confined in well corked bottles. These processes, and a variety of others, however, are quite different from the proper acetous fermentation, above described, being unattended with visible movement in the liquid with the absorption of oxygen from the air, or the evolution of carbonic acid. See the articles ACETOUS FERMENTATION, ACETIC ACID, PYROLIGNEOUS ACID, and VINEGAR.

The putrefactive fermentation is confined to those vegetable substances, in which the oxygen and hydrogen exist, in a proportion to form water; and in such, particularly, as contain nitrogen. Those proximate principles, in which carbon and hydrogen prevail, such as the oils, resins, and alcohol, do not undergo the putrefactive fermentation; nor do acids, which contain a considerable excess of oxygen, manifest a tendency to suffer this change. The conditions requisite for enabling the putrefactive process to commence, are moisture, air, and a certain temperature. The temperature most favourable is between 60° and 100° Fahr. The products of the process may be divided into the solid, liquid and gaseous. The liquid are chiefly water, together with a little acetic acid and oil. The gaseous products are light, carburetted hydrogen, carbonic acid, and, when nitrogen is present, ammonia. Pure hydrogen, and probably, nitrogen, are sometimes disengaged. Another elastic principle, supposed to arise from putrefying vegetable remains, is the noxious *miasmata* of marshes. The origin of these, however, is exceedingly obscure. The solid product is a dark, pulverulent substance, consisting of charcoal, combined with a little oxygen and hydrogen, which, when mixed with a proper quantity of earth, is called *vegetable mould*.

FERNS,—botanically *Filices*. An order of herbaceous plants, of the foliaceous division of cellulares or cryptogams. The equisetums, the lycopodiums, and the psilotums, were formerly included among ferns, but are now, with very obvious propriety, classed into two quite distinct orders. The ferns, as at present understood, comprise between 50 and 60 genera; and have within Great Britain about 100 hardy species, some of them indigenous and some exotic, about 90 greenhouse species, and about 210 hothouse species. The roots of almost all are perennial; and of some, are creeping. The stem of a few has an arborescent and leafy character; but that of the vast majority is herbaceous, dies down to the ground in winter, and never constitutes a stem in the ordinary sense of the word, but is a mere stipe, and combines with all the leafage of the plant to constitute a single frond. The leafage of some is nearly simple and entire, with reticulated veins; but that of the great majority is bipinnate, tripinnate, very compoundly pinnate, or more or less pinnatifid. The capsules are brown, membranous, usually one-celled, very minute, usually clustered in patches on the back of the frond, generally covered with an integument, called the indusium, which bursts open when they become ripe, and surrounded by a thick, articulated, elastic ring. The seeds or sporules are minute globules, discoverable only by the microscope; and, till quite a recent period, were not believed to exist.

Some ferns inhabit heaths and wastes, and grow among furze and brambles; some grow parasitically upon trees; and some inhabit arid spots, the fissures of old walls, or the cracks and almost naked surfaces of dry and barren rocks; but some overrun woods, mountain pastures, and good grass lands; and all the more luxuriant inhabit either the mossy banks of rills and fountains, the moist and moss-clad surface of dripping rocks, or moist and fertile spots in secluded and shaded situations. They abound chiefly in the tropics, and become increasingly rare as we approach the poles.

Some ferns have long been known in the practice of medicine for their purgative properties, their anthelmintic properties, their pectoral properties, or their astringent and tonic properties; and others are instruments of empiricism and mischief in the hands of quacks. The roots of some have been used for the manufacture of beer; the roots and the young leaves of others have been used as esculents; and the fronds of *Aspidium fragrans* have sometimes been used as a substitute for tea. The bulky, rank, and abundant kinds have been very extensively used for litter, for manure, for the manufacture of potash, for thatch, and, in some instances, for fodder or for the preparation of cooked food for the lower animals. Many of the exotic kinds, as well as several of our indigenous species, possess remarkable elegance; and are in multitudes of instances reared and nursed in conservatories and dwelling-houses, by curious phytologists and amateurs of plants, who have little taste or leisure for floriculture, or who are so naughty and disdainful as to pronounce that fascinating pursuit fit only for delicate ladies.

The main interest in British ferns, or at least of the very powerful concern felt in them by stock-farmers, is concentrated in the common brake or bracken, *Pteris aquilina*. See the article BRAKE. It abounds both in the rocky and heathy mountains of our pastoral districts, and in many of the rich and luxuriant grass-lands of our plains. It loves deep and dry soils, and is usually an indication of great intrinsic wealth in the land on which it grows; it overruns many of the best and driest pasture-lands which have never or not recently been turned over by the plough; and it often accumulates into absolute thickets in hollows or other sheltered spots, which possess much fertility of soil. It was formerly in great request for thatch, and usually lasted in that capacity 8 or 9 years on the north side of a roof, and 15 or 16 years on the south side; but, except in the meanest hovels, it has been completely superseded by heath, straw, tiles, and slates. It was formerly used, in considerable quantity, in both the glass and the soap manufactory; but in this capacity also, it has been entirely superseded by cheaper and better sources of alkali. It possesses sufficient astringency for the purposes of the tanner; but is far excelled by the bark of the tanniniferous trees. It has an obscure celebrity for medicinal virtues; but seems to owe that celebrity chiefly to empirics. It has, in seasons of scarcity, been used with much success as fodder; yet, in ordinary circumstances, it is, in all stages of its growth, spurned by every domesticated animal, except perhaps pigs and turnip-fed sheep. It forms good litter for the cow-house or the piggeries of cottiers or small farmers; it often serves as tolerably good manure for potato crops; it is constantly employed in some places for the winter-protection of esculent roots in pits; it serves for common fuel and for heating ovens and burning lime; it forms a shade for the tender grasses during seasons of great drought and excessive sunshine; it occasions herbage to be prolonged into winter, in situations which otherwise would have all their grasses scorched or in decay; and it frequently affords beneficial shelter to newly shorn sheep from the scorching play of sunshine; yet, regarded in the aggregate, it is one of the greatest pests of pastoral farms, and renders an enormous aggregate of the grass-lands of our country unavailable for useful purposes, or practically barren, and either chokes valuable vegetation or so completely occupies the ground as to prevent it from growing.

The extermination of the brake from pasture-lands has become a problem of much interest to stock-farmers, and is the topic of several essays in the Quarterly Journal of Agriculture and the Transactions of the Highland Society. Yet some agriculturists think it, on the whole, more beneficial than injurious. "I am of opinion," says one, "that the destruction of this plant is not a desirable object. In the works of Nature, we generally find an adaptation of means to ends; and in the habits and nature of this plant, I think I can discover the hand of an all-wise Providence. In summer, it grows with great luxuriance, entirely overshadowing the grasses, and being almost impenetrable for pasture to either sheep or cattle. In this state it continues till about the end of autumn, when it withers and dies away; and then its usefulness becomes apparent from the fine fresh bite of grass that is found at its roots. The great want on our hill-pastures is winter food; and here, by a simple plan of Nature, do we find it provided in sheltered glens or dry sunny hills, just at the season when shelter and warmth are most needed by the stock. In most of our hill-farms, where artificial food cannot be raised, a preserve like this for the stock in winter must be invaluable; and the extirpation of this plant appears to me to be an attempt of short-sighted mortals to defeat the designs of Providence." But many wild plants which often abound on good soils, thistles for example, fulfil the beneficent designs of the Creator in reminding man of his fallen state as a transgressor of the Divine law, in suggesting to him his need of salvation from sin, or even in imposing upon him healthful labour of body and mind, or in rousing his intellect and tasking his industry to the invention and execution of expedients for fertilizing the land; so that the extermination of some plants, on account of their being noxious, is just as much a duty of man and an accordance with the benign arrangements of Providence, as the cultivation of other plants on account of their being useful. Almost all plants, too, which farmers have to contend against as weeds, possess some subordinate good properties, and merely have a preponderance of pernicious or annoying qualities; and are exterminated simply on account of that preponderance. The common brake, besides, does not by any means shelter the grasses and procure a winter-bite for live stock in all circumstances; but, on the contrary, it utterly prevents the grasses from growing in some places, and causes them to become sickly and die prematurely down in others. The just or most economical view of the case seems to be this, that wherever ferns occur but sparcely, so as to shelter the soil without injuring its grasses or extracting more than a very minute fraction of its juices, they ought to be regarded as beneficial both to the herbage and to sheep, and of course let alone; but that whenever they are plentiful, so as either to choke a portion of the verdure, or to appropriate to their own use a considerable portion of the nourishment in the soil, they ought to be pronounced a nuisance and either exterminated or reduced.

Sprinkling ferns with salt or with wood-ashes has been recommended as a means of exterminating them; but it is both too expensive and of very doubtful efficacy. Pulling them has been tried; but is rendered more or less nugatory by the great length and strength of their roots. Trenching also has been somewhat unsuccessfully tried. "There is hardly another root with which I am acquainted," says the Hon. James Murray, "which is so tenacious of life as the fern; and plants which I have buried deep in the ground, beyond, as I conceived, a possibility of their vegetating, have yet in the next year sent forth their shoots." Cutting down with the scythe or otherwise, seems to succeed in some soils and situations, and to be totally inefficacious in others. It has, in various parts of Peebles-shire, occasioned the substitution of the ferns by grasses and white clover in the course of three years; yet has usually required to be repeated during five successive years in order to effect complete extermination. But in other districts in which it has been tried, it has not made the slightest impression; and even after being patiently continued through a long series of years, it has left the fern-thickets as dense and luxuriant as before it was commenced.

Irrigation seems to be the grand method, in fact the only really effective one at present known; and though hitherto tried with very various success, it probably has in any instance failed, rather from faultiness in the operation, than from any want of power in the tendency. Since our common fern cannot be subdued by maltreatment, it must be attacked by altering or destroying the conditions of soil which are requisite to its vegetation; and as it loves dryness of soil, and cannot live in moisture, it must clearly be exterminable by irrigation. Nor is the requisite process either difficult or costly; for "what can be a more simple operation to the sheep farmer, than to turn the water from some of the many streams which uselessly brawl down their channels on his lands, into small cuttings, a spade's depth, the primary one leading from the brook, along the highest part of the ground occupied by the ferns?" Irrigation, when abundant, has been known to thin and weaken the ferns in the first year, and to reduce them very nearly to utter extermination in the third or in the fourth year. A fine sward usually succeeds the disappearing ferns; and yet thistles have been known to follow so immediately and in such abundance as to threaten worse mischief than the ferns themselves; but when these do appear, they can be exterminated by two years' cutting. When water cannot be commanded for irrigation, the most feasible remedy is a persevering use of the scythe. We would suggest, too, that for the double purpose of arresting the elaboration of sap in the leaf and preventing the formation of the spores in the fructification, one cutting should take place as soon as the plant fairly exfoliates, and another about the end of June.

FERRARIA. A genus of very beautiful, Cape-of-Good-Hope, bulbous-rooted plants, of the iris tribe. The singularly magnificent though strictly ephemeral peacock tiger-flower, *Tigridia pavonia*, was originally called by Linnæus *Ferraria pavonia*, and by some later botanists, *Ferraria Tigridia*, and, though now scientifically regarded as generically different from them, may still be popularly viewed as the type of all the ferrarias. See the article TIGER-FLOWER. Seven or eight species of the genus ferraria are at present cultivated in British greenhouses; all are about 6 or 7 inches high, and are propagated from offsets; and most have flowers of a prevailingly brown colour.

FERRET,—scientifically *Mustela furo*. A domesticated species of the weasel tribe of quadrupeds. It belongs to the same genus as the common weasel, *Mustela vulgaris;* and is so nearly allied to the polecat or foumart, *Mustela putorius*, as readily to cross with it, and as to have been pronounced by some naturalists a mere variety of the same species. Its body, from the nose to the rump, is about 14 inches in length; its tail is about 5 inches in length; its nose is sharper than that of either the weasel or the polecat; its ears are round; its eyes are red and fiery; and its whole body has a very pale yellow colour. It was introduced in ancient times from Africa to Spain, in order that it might destroy rabbits; and as a domesticated animal, and a destroyer of rabbits and rats, it has spread from Spain through many other countries of Europe. It is very sensitive of cold, and requires to be kept snug in a box, a cask, or some similar place, and fed with such food as bread and milk. It has sometimes been kept in some corner of human abodes, but not without danger; for it is a blood-sucker of children as well as of rabbits, and cannot, without peril, be permitted access to bed-rooms, and especially to sleeping infants. It is commonly used to hunt and kill vermin in the farm-yard, and to capture rabbits in burrows; and when employed for the latter purpose, it is muzzled. But a mule between the ferret and the polecat is very generally preferred to the ferret itself, and not seldom passes under its name; and this is usually larger in size, stouter in form, and very considerably darker in colour than the pure ferret.

FERRUGINOUS SOILS. Soils which contain an unusually large proportion of the oxides of iron.

FERTILITY OF SOILS. The power of soils to yield such a produce of useful plants as shall compensate all the costs of cultivation, and remunerate the labours of the cultivator. This power depends partly on the mechanical conditions of the soil, and partly on its relation to the subsoil and the climate, but principally on its possessing such chemical constituents and affinities as shall yield requisite nourishment to the plants. Fertility, therefore, is in a certain degree a relative power,—so that, in some given circumstances, it may exist for one set of useful plants, and may not exist for another. It is also an exceedingly changeable power,—or very capable of both exhaustion and renovation; and according as it depends on mechanical condition, on subsoil, on climate, on chemical constituency, on chemical behaviour, or on some two or more of these, it is improved or renovated by respectively tillage, draining, fallowing, mineral manuring, organic manuring, or a combination of two or more of these operations. A fertilizer might seem to be anything, whether process or appliance, which increases fertility; but in the ordinary usage of agricultural phraseology, it means only a manure. See the articles SOIL, MANURE, and BARREN SOILS.

FERTILIZER. See FERTILITY OF SOILS.

FERULA. A genus of herbaceous plants, of the umbelliferous order. Two species of it produce the gum asafœtida of the drug shops, and may be regarded as types of the whole genus. See the article ASAFŒTIDA. One species, *Ferula villosa*, regarded by some botanists as a cowbane under the name of *Cicuta venenata*, a hardy perennial-rooted herb of about a foot in length, introduced 22 or 23 years ago from North America, is very poisonous. Nearly twenty other species, all perennial-rooted herbs, varying in height from 1 foot to 10 or 12 feet, and chiefly carrying yellow-coloured and ornamental flowers, have been introduced to Britain; and a considerable number of additional species are either unintroduced, or have been removed to other genera. The stem of some of the best known species readily offers itself as a schoolmaster's switch; hence the name ferula,—formed from a word signifying to 'strike.'

FESCUE-GRASS. See FESTUCA.

FESTING-PENNY. The earnest given to servants at the time of hiring them.

FESTUCA,—botanically *Fescue-Grass*. A genus of grasses, with many-flowered panicles, and forming the type of the suborder Festucaceæ. About 80 species of this suborder, indigenous and exotic, exist in Great Britain; and about 50 of these belong to the genus festuca; while most of the others belong to the genera mygalurus, dactylis, sclerochloa, and uniola. But 7 or 8 of these others were also at one time included in the genus festuca; about 15 or 16 additional species in Britain, now assigned to genera of other suborders, were likewise formerly included in that genus; and upwards of 20 known species still included in it have not yet been introduced to Britain. Only nine of the present festucas are indigenous in Britain; but several of the exotics, as well as most of the indigens, are hardy agricultural grasses; and so many as about twenty, including some of the old ones now removed to other genera, demand particular notice. Yet the distribution of the festucas into species, or the distinguishing of some kinds of them from others, is exceedingly difficult, and has been very conflictingly executed by different botanists, and is subject to great modification from the influence of climate and other natural agencies. Many of even the most common kinds undergo considerable variations, not alone in their minor characters, but in both the number of their flowers and the length of their awns, from change of soil and situation; and a group which figures as five distinct species, *duriuscula, rubra, glabra, glauca*, and *cambrica*, in the works of Withering, Lightfoot, Stillingfleet, Hudson, and other distinguished botanists, is regarded by Sir J. E. Smith, in his English Botany, as only one species. "In this genus," says the last of these authors, "it is hard to say what may or what may not be a species." But one character of some of the kinds or species suffers no variation, and is of very great consequence to the farmer, and always produces a very distinct and important effect upon the soil,—and that is the creeping habit of the roots; so that any farmer who makes a selection of festucas for sowing, ought distinctly to know whether the kinds he selects be creeping-rooted or fibrous-rooted. All the festucas have a loose and many-flowered panicle, either crowded or spiked; opposite, beardless, unequal glumes; two paleæ, the exterior one pointed or bearded; and seed enclosed by the paleæ.

The sheep's fescue, *Festuca ovina*, is a perennial indigen of the dry pastures of both England and Scotland. Its root is fibrous; its stem is from 6 to 15 inches in height, erect, smooth, slender, somewhat rigid, leafy in the lower part, and quadrangular in the upper part; its leaves are rough, very narrow, folded, bristle-shaped, and very numerous, and form small dense tufts of herbage; its panicle is contracted and one-sided; its spikelets are four or five flowered, and either beardless or but slightly bearded; and its seeds are small, cylindrical, and pointed at both ends. It usually flowers in June, and ripens its seed about the end of July or beginning of August. It possesses a considerable range of varieties, and exhibits considerable diversity in some of its characters, particularly in being in some instances awnless, and in others awned; and it also possesses considerable affinity to some other species, particularly to *F. rubra, F. glauca*, and *F. duriuscula;* yet it is readily recognised in its several varieties, and at the same time readily distinguished from the allied species, by its comparatively dwarfish and tufted habit of growth, by the shortness, erectness, and rigidity of its leaves, by the combined simplicity, compactness, and one-facedness of its panicle, and especially by the quadrangular outline of the upper part of its culm. It is very variously estimated, as to both its value and its economical uses, by different classes and nations of agriculturists; and has been alternately praised and depreciated as a hill-pasture grass, as a hay meadow grass, and as a lawn grass. It seems eminently adapted to all upland pastures, particularly for sheep; and has been pronounced by the most eminent judges, both scientific and practical, quite essential to the rendering of either hills or heaths of any real value as sheep-walks. It might seem from the fineness of its foliage to be suitable for lawns; but it is disqualified for them by its tufty habit of growth, by its dislike of all soils except such as are light and dry, and by the difficulty of shaving it with the scythe. It is inferior in bulk, and especially in nutritiousness, to all the other agricultural fescues; yet, in consequence of the adaptation of its fine foliage to the thoroughly reducing process of sheep's mastication, it probably yields up to their organic assimilation a larger amount of aliment than some of the more nutritious but larger and coarser grasses. In the Woburn experiments, when grown upon light sandy soil, it yielded per acre, when in flower, 5,445 lbs. of green produce, 212¾ lbs. of dry produce, and 66½ lbs. of nutritive matter; and when in seed, it yielded per acre 127½ lbs. of nutritive matter.

The barley-like fescue, *Festuca hordeiformis*, is also a perennial indigen of the dry pastures of Britain. It is regarded by some botanists as a variety of sheep's fescue, and by others as a distinct species. Its root is fibrous; its stem is from 6 to 18 inches high; its lower leaves are filiform and very fine; its panicle is compact; and its spikelets are crowded and from six to ten flowered. It usually flowers about the end of May or early in June, and ripens its seeds toward the end of June or in the beginning of July. Its culms are nearly uniform in thickness from top to bottom, and have comparatively long intervals between their knots; and are therefore well adapted to the manufacture of the finest kind of straw plait. Its awns are long, and are alluded to in its name of barley-like or hordeiformis. Its herbage is tender, succulent, and very fine, and is available for sheep somewhat early in spring. It is similar to the hardish fescue in nutritive value, but excels it both in earliness of herbage and in adaptation to dry and sandy soils; and it is entitled to a rather high rank among the agricultural grasses suitable for the best pastures. In the Woburn experiments, when grown on manured sandy soil, it yielded per acre when in flower 13,612½ lbs. of green produce, 4,083¾ lbs. of dry produce, and 478½ lbs. of nutritive matter; and, when ripe, 9,528¾ lbs. of green produce, 3,811½ lbs. of dry produce, and 260¾ lbs. of nutritive matter.

The fine-leaved fescue, *Festuca tenuifolia*, is likewise a perennial-rooted indigen of the dry pastures of Britain; and is also regarded by some botanists as a variety of the sheep's fescue, and by others as a distinct species. It abounds, along with the normal sheep's fescue, in many of the dry pastures of France; but is of comparatively rare occurrence in Britain. Its culms are shorter than those of the normal sheep's fescue; its leaves are longer and more slender; its habit of growth is less tufted; its panicles are looser, and have no awns; and its seeds are smaller and have a brighter colour. It possesses comparatively little value as a pasture grass; but is somewhat well adapted for the short thick sward of pleasure-grounds.

The viviparous fescue, *Festuca vivipara*, is a perennial-rooted native of some of the mountains of Scotland; and, like the two preceding grasses, is regarded by some botanists as a variety of the sheep's fescue, and by others as a distinct species. Its roots and its general habit are similar to those of the normal sheep's fescue; its culm is quadrangular, and usually about 10 or 12 inches high; its leaves are smooth, folded, rigid, and exceedingly narrow; its panicle is one-sided and somewhat close; and its florets are compressed, keeled, awnless, and somewhat downy. This plant does not eliminate and mature seeds for the propagation of its species, but evolves rudimental plants out of its florets, and lets them drop upon the soil while it is growing; and it retains and practises this curious habit in all sorts of situations, and takes from it its specific name of viviparous. Some other grasses, such as *Phleum pratense*, *Cynosurus cristatus*, *Anthoxanthum odoratum*, and *Alopecurus pratensis*, have also the reputation of being viviparous; but they are not really so, but naturally form and mature seeds, and then occasionally expose these to premature vegetation within the husk. The viviparous fescue can be artificially propagated only by parting the roots, or by picking off and planting the rudimental plants. But it has small value as an agricultural grass; and in the Woburn experiments, when grown upon light sand, it yielded per acre 6,806½ lbs. of green produce, and 283½ lbs. of nutritive matter.

The various-leaved fescue, *Festuca heterophylla*, is a perennial-rooted native of France, and was introduced to Britain in 1812. Its root is fibrous, its culms are numerous, erect, and from 3 to 5 feet high; its root-leaves are narrow, long, and dark green; its stem-leaves are broad and of a lighter green; its panicle is compound, loose, and slightly spreading; its spikelets are five or seven flowered; and its seeds are awned, cylindrical, and elongated. It usually flowers in June and July. It is somewhat extensively cultivated in Holland, Belgium, and some other parts of the continent; and it seems well adapted to the climate of Britain. "For one crop of hay," says Mr. Lawson, "it seems particularly well adapted, and will yield as great, if not a greater, bulk of produce than any other of the fescues whatever, but produces little else except root-leaves after being cut. Upon the whole, it seems well fitted for sowing as a mixture, either on hay or pasture lands, but particularly on the former." It possesses the advantageous property also of very freely seeding in our climate.

The hardish fescue, *Festuca duriuscula*, is a perennial-rooted indigen of the meadows and pastures of Britain. Its root, though occasionally throwing out short lateral radicles, is merely fibrous and not creeping; its stem is smooth, erect, striated, leafy, and from 12 to 24 inches high; its root-leaves are somewhat cylindrical or wire-shaped and perennial; its stem-leaves are broader and more flattened than the root-leaves; its panicle is erect, oblong, one-sided, and considerably spreading; its spikelets are oblong, and usually about six-flowered; and its florets are short-awned, or terminate in a needly point. It flowers in June and July, and matures its seeds about the end of July or beginning of August. This is one of the best of our native grasses for general utility. It thrives on widely different kinds of soils; it yields a larger bulk of produce than some agricultural grasses of taller stature; it maintains much of its verdure in winter, and resists the usually withering effect of excessive drought and heat in summer; it constitutes a large proportion of the natural herbage of some of our best pastures, which have a light and dry soil; it is well adapted, by its winter verdure and fine foliage, for forming the sward of parks and the herbage of ornamental sheep-walks; and when raised on a thin heathy soil, or on poor silicious sand, it has culms of so very fine and slender a form as to appear well suited to the straw-hat manufacture. Yet, on account of its yielding much less nourishment than some other pasture grasses, it ought not to be a prominent member in any mixture upon artificial grass lands; and it probably succeeds best when combined in due proportions with *Festuca pratensis* and *Poa trivialis*. In the Woburn experiments, when grown upon manured clayey loam, it yielded per acre, when in flower, 18,377 lbs. of green produce, 8,269½ lbs. of dry produce, and 1,005 lbs. of nutritive matter; and, when ripe, 19,057½ lbs. of green produce, 8,576 lbs. of dry produce, and 446¾ lbs. of nutritive matter.—A variety of hardish fescue called *Festuca duriuscula uri*, has few stems and exceedingly long, slender, root-leaves,—some of the latter measuring upwards of three feet.

The thicket fescue, *Festuca dumetorum*, is a perennial-rooted native of Continental Europe, and was long ago introduced to Britain. It is sometimes called pubescent wood fescue. Its root is slightly creeping; its culms are slanting; its leaves are filiform, slender, long, drooping, and of a light glaucous green colour; its panicle is branched and many-sided; and its spikelets are so exceedingly pubescent with fine hairs as to derive from them a whitish colour. It resembles the hardish, the smooth, the creeping, and the Welsh fescues, but is distinguished from them by the excessive pubescence and the distorted form of its panicle. It delights in dry and sandy soils, amid the shade of woods and thickets. It flowers in June or early in July, and ripens its seed in the latter part of July. It makes a poor growth after being cut; and is never so early a the sheep's fescue in the development of its vernal herbage. In the Woburn experiments, whe grown upon rich black sandy soil, incumbent o clay, it yielded per acre, when in flower, 10,89 lbs. of green produce, 5,445 lbs. of dry produce and 170¼ lbs. of nutritive matter; and, whe ripe, 9,528¾ lbs. of green produce, 2,858¾ lbs. o dry produce, and 223¼ lbs. of nutritive matter.

The creeping, purple, or red fescue, *Festuc rubra*, is a perennial-rooted indigen of the light dry, sandy, meadows and pastures of Britain. I has been regarded by some botanists as merely variety of the hardish fescue, and it also possesses a close relationship to the smooth and th Welsh fescues; but it is readily distinguished b the comparatively small number of its culms, by the darker tint of its foliage, and especially b the creeping habit of its root. Its leaves also ar longer than those of the hardish fescue; its panicle has longer branches; and the sheaths of it leaves are in some degree pubescent. Two varieties of it occur, the one with bristle-shaped root-leaves, and the other with broader root-leaves and the latter variety is almost as powerfull creeping in its roots as couch-grass. Either o the varieties is suitable for sowing on light blowing, littoral sands, after they have becom somewhat consolidated; but, both varieties, i consequence of their creeping habit, are wasteful members of the grasses of good lands. In th Woburn experiments, when grown upon ligh sand, the creeping fescue yielded per acre, whe in flower, 10,209½ lbs. of green produce, 4,339 lbs of dry produce, and 239¼ lbs. of nutritive matter and, when ripe, 10,890 lbs. of green produce 4,900½ lbs. of dry produce, and 340¼ lbs. of nutritive matter.

The Welsh fescue, *Festuca Cambrica*, is a perennial-rooted native of Wales. It is regarded by some botanists as a variety of the creeping fescue, but by the greater number as a distinc species. Its roots are creeping; its culms an panicles have a paler tint of green than those o the creeping, the hardish, and the sheep's fescues its spikelets are ten or twelve flowered; and it root-leaves, in a cultivated state of the plant, ar flatter and more erect than in a wild state. I flowers in June, and ripens toward the end o July. It is much scarcer than the hardish fescue, loves drier soils, and is far inferior to it in amount of produce and of nutritive matter; but it develops its herbage earlier in spring, and grows better after being cut or eaten down. Any given number of plants of it have about the same bulk and value at flowering-time as at seeding-time; but so many additional plants rise up between the two times as to render the produce at the latter much greater than at the former. In the Woburn experiments, when it was grown on sand, the Welsh fescue yielded per acre, when in flower, 6,806¼ lbs. of green produce, 2,892¾ lbs. of dry produce, and 239¼ lbs. of nutritive matter; and, when ripe, 13,612½ lbs. of green produce, 4,083¾ lbs. of dry produce, and 478½ lbs. of nutritive matter.

The smooth fescue, *Festuca glabra*, is a perennial-rooted native of Britain; but occurs chiefly on the moist parts of pastures, and is not so common as the hardish fescue. It is regarded by some botanists as a variety of the creeping fescue; but seems fully entitled to be considered a distinct species. Its root is but very lightly creeping; its culms are usually from 12 to 20 inches high; its lower leaves are much longer than those of the creeping fescue; its panicles, in both their main part and their branches, are smoother; its awns are longer; and its spikelets are glossy. It flowers in June, and ripens in the middle or toward the end of July. It precedes the hardish fescue in the development of its foliage, and excels it in the fineness and succulency of its herbage, but is inferior to it in the bulk of its produce and the amount of its nutritive matter; and when the hardish fescue cannot be obtained among fine-leaved grasses, or is not so suitable for the particular quality of the soil, this species may very properly be taken as a substitute. In the Woburn experiments, when grown upon manured sandy loam, the smooth fescue yielded per acre, when in flower, 14,293 lbs. of green produce, 5,717¼ lbs. of dry produce, and 446¾ lbs. of nutritive matter; and, when ripe, 9,528¾ lbs. of green produce, 3,811½ lbs. of dry produce, and 186 lbs. of nutritive matter.

The glaucous fescue, *Festuca glauca*, is a perennial-rooted native of the hills and mountains of various parts of Europe, particularly toward the Mediterranean. It is said to occur in a wild state in Britain; but if really indigenous, it is very rare. Its root is fibrous; its culms are smooth, and usually from 12 to 20 inches high; its leaves are smooth and glaucous; its panicle is somewhat spreading; and its spikelets are lanceolate and awned. It flowers about the middle of June, and ripens in the early part or toward the middle of July. Though naturally an alpine plant, it readily accommodates itself, in cultivation, to low situations. It is hardy and considerably nutritive; it grows in such a manner as to form a thick and dense sward; and it undergoes a change of character in its culms, from great succulency to dryness and wiriness, during the period between flowering and ripening; so that, though aggregately inferior to many other pasture grasses, it possesses recommendations for both turf and hay. In the Woburn experiments, when grown upon brown loam, it yielded per acre, when in flower, 9,528¾ lbs. of green produce, 3.811½ lbs. of dry produce, and 446¾ lbs. of nutritive matter; and, when ripe, 223½ lbs. of nutritive matter. A variety of it occurs of a glaucescent rather than glaucous character, with subulate leaves and a densely tufty habit of growth, and smaller in at once culms, leaves, and panicles, than the normal plant.

The meadow fescue, *Festuca pratensis*, called by Beauvois *Schedonorus pratensis*, is a perennial-rooted native of the meadows and pastures of Britain. It is a somewhat large ingredient in the herbage of almost all our irrigated meadows and our richest natural pastures; and, though a bulky grass, and destitute of the fineness of the small-leaved fescues and poas, it is so succulent and tender, and otherwise agreeable, as to be well relished by cattle. Its root is fibrous; its culms are usually between 2 and 3 feet high; its leaves are broad, and have a vivid green colour; its panicle is branched and spreading, and droops slightly to one side; its spikelets are long, and contain many cylindrical florets; and its outer paleæ are awnless and acute. It usually flowers in June or early in July, and ripens toward the end of July or in the beginning of August. It loves rich and rather moist soils; and does not grow in rank tufts like most of the other large grasses. It is an excellent grass for all permanent pasture on arable lands; but requires to be combined with rye-grass, cock's-foot, and rough-stalked meadow-grass, in order to be well adapted to the alternate husbandry. It develops its vernal foliage earlier than cock's-foot, but not so early as meadow foxtail; and it is more or less relished by all the domestic herbivorous animals. In the Woburn experiments, when grown upon rich peat soil manured with coal ashes, it yielded per acre, when in flower, 13,612½ lbs. of green produce, 6,466 lbs. of dry produce, and 957¼ lbs. of nutritive matter; and, when ripe, 19,057½ lbs. of green produce, 7,623 lbs. of dry produce, and 446¾ lbs. of nutritive matter.

The fertile taller fescue, *Festuca elatior fertilis*, called by Beauvois *Schedonorus elatior*, is a perennial-rooted native of Britain. It occurs, in its wild state, on moist meadows and in rich waste grounds by the side of ponds and streams. Its root is fibrous, yet has a slightly creeping habit, and sends its downy fibres deep into the clay or mud of the moist soil; its culm is smooth, reedy, striated, leafy, and usually about 4 feet high; and its panicle is widely spreading, repeatedly compound, and a foot or upwards in length. It possesses considerable affinity to the meadow fescue, but is nearly double the size of it in all its parts. A variety of taller fescue, which has sometimes been regarded as the normal plant of the species, has its leaves less smooth and of a darker green than those of the fertile taller fescue; the habit of its panicle more strictly erect; its spikelets less flat and less ovate; and the larger husks of the calyx more uniformly covered. The fertile taller fescue, though a coarse-looking grass, is generally relished by cattle, and is well adapted for either hay or permanent pasture on rich moist soils; and it possesses the recommendations of yielding an abundant crop, and ripening a profusion of seed. It flowers about the end of June or early in July, and usually ripens in the early part of August. In the Woburn experiments, when grown upon black sandy loam, incumbent on clay, it yielded per acre, when in flower, 54,450 lbs. of green produce, 23,822 lbs. of dry produce, and 4,254 lbs. of nutritive matter.

The sterile, or barren-seeded taller fescue, *Festuca elatior sterilis*, is also a perennial-rooted native of rich moist grounds in Britain, and occurs more plentifully in a wild state than the fertile variety. It has not so drooping a habit of panicle as the preceding; and possesses a nearer resemblance than it to the meadow fescue. Its root is fibrous; its panicle at first droops, and afterwards becomes erect; its spikelets are cylindrical, and generally awned; and a large proportion of its florets, especially in its wild state, are imperfect or barren. It is well adapted to strong moist soils, and particularly to soils of adhesive clay; but it requires to be propagated by division of the roots; and though it is coarse and contains but little bitter extractive, it suits admirably as hay, and has these properties corrected, by being combined with clover. In the Woburn experiments, when grown upon rich black loam, it yielded per acre, when in flower, 51,047 lbs. of green produce, 17,866½ lbs. of dry produce, and 3,988 lbs. of nutritive matter.

The reed-like or reed-wood fescue, *Festuca calamaria*, called by Beauvois *Schedonorus calamarius*, is a perennial-rooted indigen of Britain. It is far from being plentiful, and occurs only in old moist shady woods, and in some peculiar moist meadows in some parts of Scotland, Ireland, and the north-west of England. Its root is fibrous; its culms are smooth, cylindrical, leafy, erect, and usually about 4 feet high; its leaves are long, broad, tender-looking, and of a bright and vivid green colour; its panicle is erect, spreading, loose, and repeatedly compound, and has a fine delicate appearance; its spikelets are erect, comparatively small, four or five seeded, and awnless, and stand on very slender footstalks; and its glumes are small and bristle-shaped. It flowers in July, and ripens in August. It might seem to be too large and coarse to be fit for cultivation; and it suffers the disadvantage of producing a comparatively small quantity of seed; yet it well deserves attention in situations which combine shade and moisture.

The wood fescue, or slender wood fescue, *Festuca sylvatica*, called by Beauvois *Schedonorus sylvaticus*, is a perennial-rooted native of Germany, and was introduced to Britain in 1804. Its root is fibrous; its culms are usually between 2 and 3 feet high; its leaves are pointed, rough, somewhat pubescent, and of a bright green colour; its panicle is simple and drooping; its spikelets are distant, one-sided, and nearly cylindrical; and its glumes are not so long as its awns. It flowers in the early part of July, and ripens in the early part of August. It loves the shade of hedges, and of moist woods and thickets; it is very liable to become diseased at the time of flowering; it is disliked by all the principal domesticated animals, and seems to be but poorly relished by even hares and rabbits; and it therefore possesses little or no interest as an agricultural grass. In the Woburn experiments, when grown upon rich sandy loam. it yielded per acre, when in flower, 20,418¾ lbs. of green produce, 8,167½ lbs. of dry produce, and 638 lbs. of nutritive matter.

The loliaceous, darnel-like, or ryegrass-like fescue, *Festuca loliacea*, called by Beauvois *Schedonorus loliaceus*, is a perennial-rooted indigen of Britain, and loves the same kind of soils as ryegrass. Its root is fibrous; its culm is between 2 and 3 feet high; its spike is two-sided and drooping; its spikelets are linear, and nearly sessile; and its florets are awnless and cylindrical. It resembles the meadow fescue in habit of growth and bulk of produce, but differs in having a spiked instead of a panicled inflorescence, and in evincing a fondness for a greater degree of moisture; and it resembles ryegrass in its principal botanical characters, but differs in having always two glumes, in having occasionally a short footstalk, and in possessing a comparatively high perennial habit, and improving in strength and luxuriance as it advances in years. It has a larger produce than ryegrass, springs earlier, and possesses most of its advantages, unaccompanied by its defects; and it abounds in many rich meadows, particularly such as periodically enjoy a natural irrigation. But loliaceous fescue is, after all, a somewhat ambiguous name, and designates a number of rather widely different varieties of grass. "The true *F. loliacea*," says Mr. Lawson, "produces little seed, and hence has been considered a hybrid between the *F. pratensis* and *Glyceria fluitans*,—an opinion which seems justified in some respects by its growing on soils more moist than the former, but never in water like the latter. In the neighbourhood of Edinburgh, it is rarely found in a wild state, but may be seen in Dalkeith and Dalmeny Parks, as also in a marsh above the new bridge at Pathhead Ford. There are, however, many intermediate varieties between *F. loliacea* and *F. pratensis*, which have short branches towards the base of the spike, and become two-rowed towards the point; these are generally more prolific in seed, equal in value, and constitute the *F. loliacea* of the seed-shops." In the Woburn experiments, when grown upon rich brown loam, the loliaceous fescue yielded per acre, when in flower, 16,335 lbs. of green produce, 7,146½ lbs. of dry produce, and 765¾ lbs. of nutritive matter; and, when ripe, 10,890 lbs. of green produce, 4,492 lbs. of dry produce, and 553 lbs. of nutritive matter.

Wall fescue, tailed fescue, Capon's tail-grass, or tailed mousetail-grass, *Festuca myurus*, called by Link *Mygalurus caudatus*, is an annual indigen of walls, road-sides, and dry, barren, sandy spots in Britain. Its culm is from 6 to 12 inches high, and leafy from top to bottom; its leaves are awl-shaped, of the finest green colour, and, together with the culms, retain their verdure so completely through winter as to have induced many observers to pronounce the plant a biennial; its panicle is elongated, drooping, and rather close; and its florets are tapering, rough at the top, and not so long as their awns. It resembles the bromus-like fescue, but is stronger and larger, and has four times the length of panicle; and it is botanically distinguished both from that species and from all the other fescues, by having only one stamen in each flower. It usually flowers in June and ripens in July; and it sheds such a profusion of seed as to produce a more beautiful green turf by its young plants than almost any other kind of grass. But though vivid in autumn and winter, it loses its beauty in spring, and invariably becomes rusted as it approaches the time of flowering; so that it is of very small economical value to the farmer. Its seeds appear to be much relished by birds. In the Woburn experiments, when grown upon silicious sand, it yielded per acre, when in flower, 9,528¾ lbs. of green produce, 2,858¾ lbs. of dry produce, and 223½ lbs. of nutritive matter.

The bromus-like or barren fescue, or bromus-like mousetail, *Festuca bromoides*, called by Link *Mygalurus bromoides*, is an annual indigen of Britain. It frequents the same kind of situations as the wall fescue; and considerably resembles it in habit, appearance, and general character. Its root is brown and finely fibrous; its culms are from 6 to 12 inches high, and, in their upper half, are leafless; its leaves are tapering, narrow, shorter than their sheaths, and sometimes pubescent on their upper surface; its panicle is almost erect, and has somewhat the form of a raceme; and its florets are slender, cylindrical, rough at the top, and not so long as their awns. It usually flowers in May and June; and it dies speedily down after flowering. It has been mistaken by many observers for a biennial: but, though making a pleasant appearance in winter, it is a slender and very small-bodied grass, and of exceedingly trivial value to the farmer.

The single-husked fescue, or single-husked mousetail, *Festuca uniglumis*, called by Link *Mygalurus uniglumis*, is an annual indigen of the sandy sea-coast of Sussex, and of some other maritime parts of Britain. Its root is fibrous and slightly downy; its culms are simple, erect, very smooth, everywhere leafy, and from 6 to 12 inches high; its leaves are furrowed and acute, and are frequently pubescent on their upper surface; its panicle is erect and very slightly compound; its spikelets are erect or but slightly nodding; and its florets are compressed, tapering, and awned. This species, like the two preceding, has often been mistaken for a biennial, and is of small agricultural value.

The foxtail-like fescue, or foxtail-like mousetail, *Festuca alopecuroides*, called by Link *Mygalurus alopecuroides*, is a perennial-rooted native of the south of Europe, and was introduced to Britain in 1819. It usually has a height of from 6 to 12 inches, and flowers in June and July.—The festuca-like brome-grass, *Bromus festucoides*, is a perennial-rooted native of Continental Europe, and was introduced to Britain in 1826. It usually has a height of from 12 to 24 inches, and flowers in June and July.—The foxtail brome-grass, *Bromus alopecurus*, regarded by some botanists and agriculturists as a fescue under the name of *Festuca alopecurus*, is an annual-rooted native of Barbary, and was introduced about half a century ago to Britain.—These three species appear to be sometimes confounded with one another; and the last, in particular, has very commonly been classed with the agricultural fescues. Its culms are erect, smooth, and between 2 and 3 feet high; its leaves are smooth, channelled, linear, and often very long; and its florets have a long, straight, flat, lateral pubescence, which readily distinguishes them from those of all the true fescues. It usually flowers about the end of July, and ripens about the beginning of September. Its culms are very innutritious; but its leaves constitute good herbage. In the Woburn experiments, when grown upon sharp sand, it yielded per acre, when in flower, 8,167½ lbs. of green produce, 2,624¼ lbs. of dry produce, and 319 lbs. of nutritive matter.

The sand fescue, *Festuca arenaria*, is a perennial-rooted indigen of the sandy sea-coasts of some parts of Britain. It abounds in company with *Ammophila arundinacea*, *Elymus arenarius*, and some other lovers of dry, drifting, arenaceous spots, on the border of the Sands of Barry on the coast of Forfarshire. Its root is creeping; its culms are nearly erect, have large and slightly-kneed joints, and usually attain a height of about 18 or 20 inches; its lower leaves are long, wiry, and amassed into bundles by reddish-coloured sheaths; its upper leaves are long and considerably flattened; its panicle is large, and spreads to one side; its spikelets are seven or nine flowered, and nearly awnless; and its glumes are smooth and very observedly three-nerved. "The cultivation of this fescue," says Mr. Lawson, "has never been attempted on an extensive scale; but it would no doubt succeed well on light sands, yielding on such a considerable quantity of nutritious animal food, where few other grasses will grow, except the sand lyme and reed grasses, which cattle refuse to eat. It is noticed by some botanists as being only a variety of *F. rubra* or *F. duriuscula;* but whether it be entitled to rank as a distinct species or not, it is certainly very distinct from either in habit and appearance."

The giant fescue or giant brome-grass, *Festuca gigantea* or *Bromus giganteus*, is noticed in our article Bromus.—The spiked heath fescue, winged brome-grass, or winged brachypodium, *Festuca pinnata*, *Bromus pinnatus*, or *Brachypodium pin-*

natum, is a perennial-rooted indigen of some of the heaths and woodlands of some parts of Britain. It occurs sometimes on the heaths and commons of the chalk districts of England, and more frequently in dry and upland woodlands in the limestone districts of both England and Scotland. Its root is scaly and somewhat creeping; its culms are usually about 4 feet high; its leaves are nearly smooth; its spike is simple, two-ranked, and erect; its spikelets are a little distant from one another, and nearly cylindrical; and its awns are shorter than the husks, and spread a little after the flowering. It flowers throughout July, but chiefly in the latter part of it, and ripens late in August. It possesses characters intermediate between those of the true fescues and those of the true bromes. It is superior to many of our native grasses in bulkiness, but is comparatively innutritious, is late in developing its herbage, and is not well relished by cattle; so that it ranks far more as a weed than as an useful agricultural grass. In the Woburn experiments, when grown upon manured sharp sand, it yielded per acre, when in flower, 20,418¾ lbs. of green produce, 8,167½ lbs. of dry produce, and 398¾ lbs. of nutritive matter.

FETLOCK. The part of a horse's leg, at which the tuft of hair grows behind the pastern. The joint of this part is called the fetlock-joint, and is the principal seat of motion below the knee. Four bones belong to it,—the cannon bone, the long pastern bone, and the two sessamoids; and extraordinary provision exists in its configuration and accompaniments to obviate concussion. Inflammation in the ligaments of this joint attends most cases of sprain of the back-sinew; and inflammatory action in these ligaments or in the parts immediately connected with them is frequently mistaken for sprain in some higher part of the leg. When the affection is mild, cooling lotions may subdue it; but when it is somewhat severe, especially if it be so bad that the horse cannot freely or at all use the limb, smart fomentation and prompt blistering are required.

FETTER. A chain or strong rope used for confining the feet of any domestic animal, or for temporarily limiting its range of pasturage in a field to a mere patch of the ground.

FEUILLEA. A genus of tropical and Australian plants, of the gourd family. The fruit of the heart-leaved species, *F. cordifolia*, a native of Australia, is believed to be a complete antidote to the poison of hemlock, nux vomica, swamp sumach, and some other highly noxious plants.

FEVER. Accelerated arterial action in the vascular system of animals. The fevers of the horse bear very little analogy to those of the human subject, and require a different treatment. Many kinds of horse fevers have been described by writers on farriery; but most exist only in the imagination of the writers, or have been manufactured out of the mistaken analogies of human fevers. All the real fevers of the horse may be comprised in two,—the idiopathic or pure or simple fever, constituting of itself an entire disease,—and the symptomatic fever, occasioned by inflammatory action in some particular internal part of the body, and constituting rather the attendant of a disease than the disease itself.

Some writers deny the existence of idiopathic fever; and others, while overtly admitting it, either ascribe it to some latent inflammation which speedily becomes developed, or allege that it soon originates local inflammation, and exchanges its own proper character for that of symptomatic fever. But though idiopathic fever is comparatively infrequent in occurrence, it unquestionably meets the attention of most persons who have extensive stable management of horses; and its general tendency to degenerate into local inflammation and symptomatic fever, seems to arise far less from its own nature than from foul air, vicissitudes of temperature, and general bad treatment. If idiopathic fever be not easily reduced, the blood accumulates in the lungs, the viscera, or some other interior part of the body, and provokes inflammation; or if a horse, while suffering under this fever, be kept in a foul or ill-ventilated stable, or be subjected to alternations of heat and cold, he speedily becomes locally inflamed from the action of the filth or the air. The symptoms of idiopathic fever are shivering, loss of appetite, dejected appearance, quick pulse, hot mouth, and some degree of debility; generally, also, costiveness and obstruction of urine; and sometimes, likewise, quickness of breathing and such pain in the bowels as accompanies colic. "As soon as a horse is attacked by this disease," says White, "let him be bled freely; and if costiveness is one of the symptoms, give a pint of castor oil or the oil of olives, and let a glyster of warm gruel be injected. The fever powder, consisting of one ounce of powdered nitre, two drachms of camphor, and two drachms of tartarized antimony, is to be given once in twelve hours, and continued until its diuretic effect becomes considerable. Warm water and mashes are to be frequently offered in small quantities; warm clothing, frequent hand-rubbing, and a liberal allowance of litter are also necessary; and when the fever runs high, it is advisable to insert rowels about the chest and belly, in order to prevent internal inflammation from taking place. When the disease appears to be going off, the horse looking more lively, and the appetite returning, let him be led out for a short time in some warm situation, and give now and then a malt mash for the purpose of recovering his strength." Youatt recommends simply bleeding, relaxation with small and repeated dozes of aloes, and sedative action with judiciously proportioned dozes, twice-a-day, of digitalis, emetic tartar, and nitre; and he warns against active purging from the danger of exciting inflammation. The horse should be kept warmly clothed, but the stable cool and well ventilated. Idiopathic fever, if it do not pass into inflammation, never kills, but is always curable.

Symptomatic fever is the attendant of inflammation in some particular part of the body, and, conjointly with the primary disease, is always more violent and dangerous than idiopathic fever; and, though it requires in very bad or peculiar cases to be treated as if it were itself the primary disease or nearly in the same manner as idiopathic fever, yet it ought generally to be viewed as a mere symptom, and will be found to subside simultaneously with the reduction of the disease which excites it. The chief thing connected with it is to mark the special varieties of its indications, as means of ascertaining the precise seat and modification of inflammation which causes it, and therefore as indices of the special varieties of treatment to be pursued. When the inflammation arises from excessive and prolonged exertion, the symptomatic fever is suddenly developed, and early exhibits a violent character; but when the inflammation arises otherwise, the symptomatic fever is gradually developed, and presents at first a mild appearance; and, in any case, it is not preceded by shivering. The principal symptoms common to it and idiopathic fever are loss of appetite, quick pulse, dejected look, hot mouth, and debility. "If to these symptoms are joined difficulty of breathing and quick working of the flanks, with coldness of the legs and ears, we may conclude that an inflammation of the lungs is the cause of the fever. If the horse hangs down his head in the manger, or leans back upon his collar with a strong appearance of being drowsy, the eyes appearing watery and inflamed, it is probable that the fever depends upon an accumulation of blood in the vessels of the brain, and that the staggers are approaching. In this case, however, the pulse is not always quickened; but sometimes is unusually slow. When the symptoms of fever are joined with a yellowness of the eyes and mouth, an inflammation of the liver is indicated. Should an inflammation of the bowels be the cause, the horse is violently griped. An inflammation of the kidneys will also produce fever, and is distinguished by a suppression of urine and an inability to bear pressure upon the loins. When inflammation of the bladder is the cause, the horse is frequently staling, voiding only very small quantities of urine, and that with considerable pain. Extensive wounds, and particularly those of joints, will also produce symptomatic fever. Sometimes several of the internal parts are inflamed at the same instant; and indeed when inflammation has existed for a considerable length of time, it is seldom confined to the organ in which it originated; the disease spreads to other viscera,—and when more than one organ is inflamed, the symptoms will generally be complicated. Still, however, the essential remedies are the same, that is to say, copious and early bleeding, with rowels and blisters." See the articles INFLAMMATION, PNEUMONIA, STAGGERS, KIDNEY, WOUND, STOMACH, LIVER, CATARRH, ENTERITIS, and PLEURISY.

Cattle are subject both to idiopathic fever and to symptomatic fever, very nearly in the same manner as the horse, and require, when suffering them, to be very similarly treated. The idiopathic fever of cattle has, in many instances, an intermitting character, which may easily be subdued by means of ordinary care and of cordial purgatives; and, in other instances, has a steady and unintermitting character, and is exceedingly liable to resolve itself into pleurisy, enteritis, or some other inflammatory disease. The symptomatic fever of cattle is strictly parallel to the symptomatic fever of horses, and is determined, as to both symptoms and proper treatment, by the particular seat and nature of the exciting inflammation. But besides these fevers, cattle are subject to two very destructive and quite distinct kinds of fever, both of an epizootic character, and till of late years not at all understood, the one of a virulent and the other of a chronic character, the former inflammatory and the latter typhoid; and these will form the subjects of our articles INFLAMMATORY FEVER and TYPHUS FEVER. Numerous modifications of these fevers, or particular phases of them, are more or less extensively known among farmers under the names of hose, quarter-ill, black-quarter, joint-felon, black-leg, blain-of-the-tongue, murrain, joint-murrain, distemper, short-of-blood, striking-in-of-the-blood, and a number of others; and all the chief of these will be found noticed in articles of their own. The fever which, in many instances, follows parturition, particularly in the cow and the ewe, will form the subject of the article PUERPERAL FEVER. The ordinary fevers of dogs and other domestic animals follow, upon the whole, the same general law as the ordinary fevers of the horse, and are classifiable into idiopathic and symptomatic.—*The Veterinarian.—Bartlet's Farriery.—White's Veterinary.—Winter's Horse in Health and Disease.—Blaine's Veterinary Art.—Youatt on the Horse.—Youatt on Cattle.—Blaine's Canine Pathology.—Quarterly Journal of Agriculture.*

FEVERFEW,—botanically *Pyrethrum*. A genus of ornamental plants, of the chamomile division of the composite order. The common feverfew or pellitory, *Pyrethrum parthenium*, is a herbaceous indigen of Britain. It grows in walls, hedges, waste grounds, heaps of rubbish, and similar situations; it is extensively cultivated in gardens, partly for sake of its medicinal properties, but chiefly for sake of its ornamental appearance; it is popularly regarded as a biennial, but may be prolonged into a course of several years; and it continues green throughout the winter, and usually blooms from June till September. Its root is small, tapering, white, and pungent-tasted; its stem is erect, round, branched, leafy, and about two feet high; its leaves are pinnatifid, petiolate, and of a hoary green colour; and its flowers grow in corymbose panicles, are very numerous, and have a considerable resemblance in form, colour, and size, to common white daisies, but are both brighter and neater. The whole plant has a strong unpleasant odour, and a bitter taste, and yields by distillation a volatile oil. Its leaves and flowers have long been used in medicine; they were formerly used much in hysterical complaints and affections of the womb; they are still esteemed antihysterical, tonic, and stimulating; and either by themselves, or along with other parts of the plant, they furnish one of the most common and extensively used medicines of the homœopathists. The volatile oil yielded by the plant contains a large proportion of tannic acid, and has been extensively employed in Germany in the manufacture of leather. Several double-flowered varieties are very generally cultivated in our flower-gardens, and make a good figure on the open border. The oldest of these varieties are one with very double-flowers, one with plain rays and fistular disk, one with very small rays, one with very short fistular florets, one with naked heads or without rays, one with naked sulphur-coloured heads, and one with elegant curled leaves. The generic name Pyrethrum is derived from a word signifying "fire," and alludes to the hot taste of the roots; and the specific name Parthenium is derived from a word signifying "a virgin," and alludes to the reputed medicinal power of the plant in female complaints. This plant was formerly regarded as a matricaria, and supposed to be closely akin to the common wild chamomile.

The scentless feverfew or scentless Mayweed, *Pyrethrum inodorum*, abounds in the dry soils of many parts of Britain, and particularly in cultivated gravelly lands. It is an annual. Its root is tapering and rather large; its stem is smooth, angular, branched, leafy, and about a foot high; its leaves are pinnate and sessile; and its flowers are similar to those of the common feverfew, and bloom in August and September.—The sea feverfew, *Pyrethrum maritimum*, is a perennial-rooted native of sandy and stony situations on the sea coasts of Britain. Its root is woody, decurrent, and long-lived; its stems are hollow, spread athwart the ground, have seldom a height of more than about a foot, and are frequently tinged with purple; its leaves are sessile, crowded, bipinnate, and of a dark glossy green colour; and its flowers are not so broad as those of the preceding species, and bloom from June till October.—About fifty species, all more or less ornamental, have been introduced from foreign countries; and eight or nine of these are evergreen and almost constantly flowering shrubs from the West-African Islands, nine or ten are hardy annuals or perennial herbs with yellow or reddish flowers, and most of the others are hardy perennial herbs with white flowers.

FEVERWORT, — botanically *Triosteum*. A small genus of plants, of the honeysuckle tribe. The perfoliate species, *Triosteum perfoliatum*, is a hardy perennial-rooted herb of North America, and was introduced to Britain in the early part of last century. It abounds on low marshy grounds in New England; and possesses some celebrity as a medicinal plant. Its root consists of thick, rough, contorted fleshy fibres; its stems are strong and about 18 inches high; its leaves are oblong, broad, and sessile, and grow in pairs at the joints of the stems; and its flowers come out in whorls from the bosom of the leaves, have a dark red colour, and bloom in June and July. This plant is popularly known in America under the names of Tinker's weed and false ipecacuanha. A yellow-flowered species, somewhat similar to the preceding, was introduced to Britain from Virginia about the end of the 17th century.

FIARS. The average prices of grain throughout a year, in each of the counties and stewartries of Scotland. These prices are determined, or "the fiars are struck," in the month of February by the sheriffs and stewards, aided in every instance, except that of East-Lothian, by a jury; and they constitute the final appeal in all bargains of reference, and the conversion price of rents and of the stipends of the clergy. The form of striking the fiars is prescribed by acts of Dec. 21, 1723, and Feb. 29, 1728. "A jury," says Bell, "must be called, and evidence laid before them of the prices of the different grains raised in the county; and the prices fixed by the opinion of the jury, and sanctioned by the judge, are termed the fiars of that year in which they are struck, and regulate the prices of all grain stipulated to be sold at the fiar prices; nor will an error in striking them afford a ground of suspension. They regulate also all cases where no price has been stipulated for grain delivered, which is the produce of the county." The practice of striking fiars of cattle, sheep, wool, and other produce of stock-farms, or of the live-stock department of mixed farms, ought also to be introduced, and would be productive of some highly beneficial effects,—among others, the equitable adjustment of rent, and the proper valuation of stock on a change of occupancy.

FIBRE. An organic filament or cord. The fibre of plants consists principally of lignin; and the fibre of animals consists principally of fibrin. The muscular or fleshy fibre is composed of a particular kind of filaments, having the peculiar property, during life, of contracting or folding themselves up, when touched or injured by any external body; or when acted upon, through the medium of the nerves, by the will. The muscles are the immediate organs of voluntary motion, and are composed entirely of bundles of fleshy fibres. All the membranes and vessels, which are required to exercise any compressive force, are armed with these fibres. They are always united intimately with the nervous filaments, or threads; but certain muscles are observed to execute motions, altogether independent of the will, especially in the exercise of functions possessed in common with plants. Thus, although the will is frequently the cause of muscular motion, yet its power is neither general nor uniform in its action. Fleshy fibre has, for the basis of its composition, a particular principle, named *fibrin*, which is nearly insoluble in boiling water, and seems naturally to assume a filamentous arrangement. See the articles FIBRIN, GROWTH, and LIGNIN.

FIBRIN. A peculiar organic compound, found both in vegetables and animals. It is a soft solid, of a greasy appearance, nearly insoluble in water, which softens in the air, becoming viscid, brown, and semi-transparent. On hot coals it melts, throws out greasy drops, crackles, and evolves the smoke and odour of roasting meat. It is procured, in its most characteristic state, from animal matter. It exists in chyle; it enters into the composition of blood; and it forms the chief part of muscular flesh; and hence it must be regarded as the most abundant constituent of the soft solids of animals. According to the analysis of MM. Gay-Lussac and Thenard, it is composed of carbon 53.36, nitrogen 19.934, oxygen 19.685, and hydrogen 7.021; but, according to Mulder, it is isomeric in these four elements with albumen and casein, and also contains minute proportions of sulphur and phosphorus.

FIBROUS PLANTS. Plants which are or might be cultivated for the manufacture of their filamentous fibres into cordage or woven fabrics. The principal are common flax, *Linum usitatissimum;* perennial flax, *Linum perenne;* common hemp, *Cannabis sativus;* common hop, *Humulus lupulus;* the hemp nettle, *Urtica cannabina;* the Canadian nettle, *Urtica canadensis;* the common nettle, *Urtica dioica;* New Zealand flax, *Phormium tenax;* hemp marsh-mallow, *Althæa cannabina;* common tree mallow, *Lavatera arborea;* the common Spanish broom, *Spartium junceum;* the common broom, *Cytisus scoparium;* the one-seeded broom, *Cytisus monospermum;* the white Portugal broom, *Cytisus multiflorum;* the common herbaceous cotton plant, *Gossypium herbaceum;* the other agricultural cotton plants, *G. vitifolium, G. barbadense, G. obtusifolium, G. hirsutum, G. indicum, G. latifolium, G. acuminatum,* and *G. religiosum;* the Canadian hemp, *Apocynum cannabinum;* the Syrian swallow-wort, *Asclepias syriaca;* the broad-leaved sida, *Sida abutilon;* the sea-side reed-grass, *Ammophila arundinacea;* and the common lime-tree, *Tilia Europæa.*

FICARIA. See PILEWORT.

FICOIDEÆ. A natural order of plants, nearly allied to the Cacti and the Crassulaceæ. All grow in dry or saline situations; most inhabit the hot parts of the temperate zones; the greater number occur at the Cape-of-Good-Hope; all possess saline secretions and a comparatively great degree of succulency; and some exhibit the most remarkable combination of extraordinary form and ornamental appearance anywhere found in the vegetable world. Five or six stove species, three hardy species, and about 450 greenhouse species occur in the gardens and botanical collections of Britain; and these are classified into eight genera, the most remarkable of which is mesembryanthemum.

FICUS. See FIG-TREE.

FIDDLEWOOD,—botanically *Citharexylum.* A genus of tropical, evergreen, ornamental trees and shrubs, of the verbena tribe. The square-stemmed species, *C. quadrangulare,* is a timber-tree of the West Indies, of usually about 50 or 60 feet in height; and this and eight or nine shrubby species of from 6 to 24 feet in ordinary height, have been introduced to British collections.

FIELD. A division or subdivision of a farm, whether for tillage or for pasture. Before the era of enclosures, fields were simply the portions of farms or estates in tillage; and since the general prevalence of enclosures, they are, for the most part, identical with all enclosures devoted either to tillage or to pasture. Everything, therefore, which concerns the size, the shape, the arrangement, the slope, and the contiguity of fields, has already been stated in the articles ENCLOSURE and FARM. Each field on a farm has or ought to have a distinctive name; and the collective fields of a mixed or a tillage farm are or ought to be successionally managed in strict and regular adaptation to a systematic course of cropping.

FIELDFARE,—scientifically *Turdus pilaris.* A British winter-bird of the thrush family. It is about ten inches long, has ash-grey plumage, mottled with brown, and is white on the belly, reddish brown on the breast, and golden amber on the throat. It spends the summer in Scandinavia, comes to Britain about the beginning of November, and returns to Scandinavia in spring. The fieldfares while in Britain fly in flocks, are very shy, justly dread the approach of man, and usually manage to keep beyond the limits of musket-range. In open weather, they frequent pasture lands, and feed upon worms, slugs, and larvæ; and during frost and snow, they retreat to hedges and thickets, and feed upon the fruit of the hawthorn, the holly, and the mountain ash.

FIELD-GARDEN. See ALLOTMENT-SYSTEM.

FIELD-GATE. See GATE.

FIELD-LARK. See LARK.

FIELD-MADDER,—botanically *Sherardia.* A small genus of hardy annual plants, of the madder family. The corn-field species, *Sherardia arvensis,* is a weed of the fallow fields of Britain. It particularly frequents light gravelly soils. Its stems are branched, spreading, principally decumbent, and from 3 to 8 inches long; its leaves are whorled, pale green, and pubescent; and its flowers grow in a terminal raceme, have a pale purplish blue colour, and bloom from April till September.

FIELD-MICE. Two species of mischievous

little quadrupeds, of the rat family and rodentia order of the mammalia.

The long-tailed field-mouse, *Mus sylvaticus*, belongs to the same genus as the common mouse. Its head and body are a little upwards of three and a half inches in length; its tail is somewhat shorter than the head and the body; its ears are upwards of half the length of the head: its colour is reddish brown above and whitish below; and its eyes are full and black. It occurs in all the mild districts of Europe; frequents woods, orchards, and gardens; and, in some places, exists in countless and almost incredible multitudes. It strips off the bark of shrubs and trees, roots up newly planted acorns, destroys the shoots and twigs of wood nurseries, digs up the newly sown pease and beans of the kitchen-garden, damages or devastates wheat-fields, and sometimes makes dreadful havoc upon either orchards or plantations. Buffon states that so many as 2,300 long-tailed field-mice were caught in the course of 23 days by a single trap in a field of about 40 acres; and other writers mention instances of such hosts of them as totally destroyed several contiguous acres of young plantations. When hard pressed for their proper vegetable food, these little creatures prey upon young birds, and even upon one another, the strong eating up the weak; and in some instances they are attacked, and even whole colonies of them exterminated, by troops of the short-eared owl.

The short-tailed field-mouse, or field-vole, *Arvicola agrestis*, is a far more mischievous animal to the farmer than the long-tailed field-mouse, and indeed is, in some places, the most destructive kind of vermin on a farm. Its head and body are rather upwards of 4 inches in length; its tail is one inch and 3½ lines in length; and its colour is reddish-brown above and grey below. It occurs throughout the greater part of Europe, and is particularly abundant in France and England. It frequents woods, meadows, and corn-fields; sometimes exists in prodigious multitudes; and not infrequently multiplies with such rapidity, and commits such enormous depredations, that it requires to be vigorously kept down by means of birds and beasts of prey. It destroys both plantations and corn-crops; and, in many instances, has been the terror and even the ruin of both forester and farmer. In 1813 and 1814, it committed such ravages in the New Forest and the Dean Forest as to threaten the extermination of all the young trees in these vast woods. "A sudden and rapid increase of mice," says Mr. Jesse, "took place in these forests, which threatened the destruction of the whole of the young plants: vast numbers of these were killed, the mice having eaten through the roots of five-year-old oaks and chestnuts, generally just below the surface of the ground. Hollies, also, which were five or six feet high, were barked round the bottom; and in some instances the mice had crawled up the tree, and were seen feeding on the bark of the upper branches." In the Dean Forest, about 30,000 were caught, in the course of about three months, in holes made to entrap them, and a much larger number were destroyed by cats, weasels, owls, kites, hawks, crows, and other beasts and birds of prey; and in the New Forest, probably about 100,000 were either entrapped or killed; so that, in the two forests, the enormous number of about 200,000 were destroyed. The depredations of these little creatures upon corn-fields, particularly in digging up and devouring newly-sown wheat, have at times been so great as materially to depress the interests of agriculture throughout entire districts. "From Augerville," says a published notice of the year 1835, "it is stated that ten bad crops which have occurred during the last fifteen years have almost ruined our cultivators, and have caused many farms to be tenantless, the occupiers returning them on the hands of the landlords as the leases fall in. One proprietor alone in this district has now five or six farms in this predicament. The cause of all this distress is attributed to the field-mice. They devastate every spot; and this year they have invaded fresh districts, and some growers have delayed sowing their wheat till spring, there being no chance of protecting it from the vermin; and in such cases, the mice have forsaken the fields where they could not find subsistence, to prey on the seed in situations where such precaution had not been used."

Field-mice, when not excessive in numbers, ought to be kept down and if possible exterminated by means of traps, cats, ferrets, and terriers; and when they become multitudinous, or begin to perpetrate serious mischief, they ought to be caught in holes of about a foot each in depth, and so dug and shaped as to be wider at the bottom than at the top.—A field-vole or short-tailed field-mouse, of smaller size and longer tail than the common short-tailed field-mouse, and differing from it in some of its anatomical characters, occurs in some parts of England and of Continental Europe; and this is variously designated by different zoologists *Arvicola pratensis*, *Arvicola rufescens*, and *Arvicola riparica*.

FIELD-SPORTS. The several amusements of sportsmen, but particularly those of the chase. They sometimes inflict wanton and severe injury upon the farmers' fields in autumn; but they do little or no injury to them in winter, when the fields are clear of both crops and stock. These sports are more or less loved by many farmers, and are often thought, when moderately indulged in, to have a healthy influence upon the mind; but they really squander valuable time and means, dissipate the intellectual habits, tempt to the neglect of current duties, blunt or pervert the moral feelings, and in general act maliguly on both the purse and the heart.

FIELD-VOLE. See FIELD-MICE.

FIELD-WORKERS. See FARM-LABOURERS.

FIG. The fruit of the fig-tree. See the article FIG-TREE.

FIG. A tumour or fungous wart on the sole of the horse, and sometimes on other parts of his body. A fig on the sole discharges a fetid malignant humour, and is very difficult to cure.

FIG-MARIGOLD. See MESEMBRYANTHEMUM.

FIG-TREE,—botanically *Ficus*. A large genus of tender, ornamental, dendritic plants, of the nettle order. About 80 species have been introduced to the conservatories and hothouses of Britain from India, Southern Africa, South America, Australasia, and other parts of the world; and upwards of 60 other species are known. Most of the introduced species are evergreen shrubs or evergreen trees, varying in natural height from 3 to 85 feet; but by far the best known one is a small deciduous tree, and three or four are evergreen ligneous creepers or trailers.

The common fig-tree, *Ficus carica*, is a well-known species of fruit-tree, a native of Asia, Africa and the south of Europe, which has been cultivated, from remote antiquity, in the countries surrounding the Mediterranean, where it forms a principal article of food in many places; and it was first introduced to Britain about the middle of the 16th century. The stem is from 15 to 25 feet high, with a trunk sometimes two feet in diameter, giving out a great number of long, twisted, pliant branches, which are greyish and rough when young; the leaves are deciduous, of the size of the hand, having three to five rounded lobes; the flowers are very small, unisexual, contained in great numbers in a common receptacle, which is fleshy and connivent at the summit, where it is almost closed by a series of little teeth; the male flowers occupy the superior part of this receptacle, and the female, which are the most numerous, the bottom, and all the remaining part of the cavity; each ovary becomes a seed, surrounded with a pulp, which, together with the receptacle, forms the fruit. The fruit is solitary, generally of a purplish colour, has a soft, sweet, fragrant pulp, and is much esteemed, being constantly brought upon the table, during five months of the year, in the south of Europe.

The process of increasing and ripening the fruit is an art which requires much attention. This, as it is practised in the Levant, is called *caprification*, and is a very interesting process. It is thus described by Tournefort, and other travellers in the East. The operation is rendered necessary by the two following facts, viz., that the cultivated fig bears, for the most part, female flowers only, while the male flowers are abundant upon the wild fig tree; and, secondly, that the flower of the fig is upon the inside of the receptacle, which constitutes the fruit. It is hence found necessary to surround the plantations and gardens, containing the figs, with branches and limbs, bearing male flowers from the wild fig-tree; thus preparing the way for the fertilizing the female flowers in the garden. And from these wild flowers, the fertilizing pollen is borne to the other figs upon the wings and legs of small insects, which are found to inhabit the fruit of the wild fig. It requires, therefore, a very particular observation and careful study of the wild fruit to know the precise time when the insects will be ready to take wing, or they might be lost. When it is found they are just ready to leave the fig, the boughs are placed as above described, and an abundant crop is the result. The ripening of the fig is rendered more certain and speedy by touching the eye of the fruit with a little oil.

The fig-tree, in its wild state, is a low, distorted shrub, bearing fruit destitute of any agreeable flavour. Dried figs are easier of digestion and more nourishing than the fresh fruit, and form a considerable article of commerce. The best come from Turkey, Italy, Spain and Provence; those of the Archipelago are inferior in quality. Dried figs, with barley bread, are now the ordinary food of the lower classes in Greece and the Archipelago. The ancients procured a sort of wine from figs by a method which is still in use in the Archipelago.

In this country, fig-trees require good walls, with south-east, south, or south-west aspects, and they occupy a good deal of space. It is proper, therefore, to select only such kinds as are likely to be productive. The trees likewise require careful management. Britain is certainly not the country for fig-trees; yet with due attention, fresh figs matured on the open walls, may grace the dessert from the middle of August to the end of October; and by means of a fig-house, or even of dwarf fig-trees planted in front of a vinery, the season may be prolonged till December. In the neighbourhood of Worthing and West Tarring are good fig-orchards, some of which produce annually, from standard trees, 1,000 to 1,500 dozen good figs. It may here be remarked, that the fig in a fresh or a green state, being a scarce fruit in this country, is often cut into longitudinal slices at the dessert; a good deal of the flavour is thus lost. Abroad, the person who eats a fig, holds it by the small end, and making a circular cut at the large end, peels down the thick skin of the fruit in flakes, the soft interior part forming only a single *bonne bouche*. A friable loamy soil is best for fig-trees. French writers recommend light and poor soil, even sandy and gravelly; but in such situations in this country the tree does not succeed; and in any very dry soil the fruit is apt to fall off. If however the soil be otherwise good, the recurrence of this last inconvenience may in general be prevented by watering and *mulching*. A free exposure to air and sun is indispensable to the perfection of the fruit.

In the public nurseries, fig-trees are often propagated by suckers, and sometimes by cuttings. The cuttings are taken off in autumn, sunk in the ground, and protected with old bark and haulm during winter. Neither cuttings nor suckers form nearly so good trees as those procured by layers, provided the layers be formed of bearing branches. Indeed a single plant thus procured, by *layering*, from a tree in a full bearing state, and from the bearing wood of such a tree, is worth many others. In general a young fig-tree is at first trained with three branches, nearly upright, this direction encouraging their rapid growth. If horizontal training be adopted, the two outer branches are afterward laid down horizontally, and from these upright branches are suffered to rise, at the distance of a foot or sixteen inches from each other. From the central shoot other shoots spring, and these are successively laid in horizontally at the distance perhaps of two feet from each other. The mode of training, however, generally adopted in this country, and approved by the best gardeners, is the fan-shape; keeping the outer branches nearly horizontal, so as to allow ample space for laying in the central ones. In some instances they are trained in the Dutch mode, with only two low horizontals, and upright shoots from these. In a few places in England, fig-trees are trained to espalier-rails. Sometimes these trees are untied, and, during the severity of winter, the branches are laid close to the ground in bundles, and well covered with straw or haulm, over which some earth is heaped. Another method of protecting them, employed both in England and France, is the erecting of two screens of reeds, one on each side of the rail. The fruit proceeds immediately from the eyes of the shoots without visible blossom; indeed the parts of fructification are entirely within. In warm countries two crops are produced yearly, one upon the former year's shoots, and another on the shoots of the same year. In this country the first of these crops is the only one to be depended on; the second often makes its appearance, but the figs are little larger than peas when arrested by the cold of approaching winter. Some gardeners direct that these young fruit be carefully swept from the branches at the winter's dressing; but a more cautious observer, Mr. Smith at Hopetoun House, has found that, while he freed the trees of all half-ripened fruit, if he could save the very young fruit over winter, they afforded, as might be expected, the earliest figs in the following season. While the fruit is ripening, such leaves as cover it, should be braced to the wall with small cross-sticks, and not cut off as is sometimes done.

In pruning fig-trees, the shoots of the former year must not be shortened, the fruit being produced at the upper part of these. When a branch becomes naked, or destitute of *laterals*, some advise the cutting it entirely out from the base; but if it be shortened, plenty of young shoots will in general be the result. Nicol remarks, that the most fruitful shoots are short-jointed, round, and not of length proportional to their thickness. The time usually chosen for pruning is April or early in May; but some gardeners still prefer the autumn, as recommended by Miller, when less sap issues from the wounded parts. In preparing the trees for winter, the branches are closely nailed to the wall; and when frost approaches, coverings of bass-mat, straw-screens, or some such means of defence, are employed. Perhaps the best mode of protecting them, is described by Mr. Smith, in the second volume of Scottish Horticultural Memoirs. He recommends the use of spruce-fir branches, four or five feet long; these are fastened to the wall, each branch by two different points of attachment; and the tree is thus covered as equally as possible. The spruce-fir possesses this advantage, that the branches remain green over winter; and in March, when the days lengthen, the leaves begin to fall off, thus gradually admitting more and more air to the trees as the season advances. By adopting this method, Mr. Smith has never failed to have good crops of figs. At Argenteuil near Paris, the culture of fig-trees is one of the chief employments of the people. The custom there, is to protect the branches by laying them down in the earth, and keeping them covered with soil for the space of two months and a half during winter. The principal pruning is there performed in the spring, by rubbing off the superfluous wood-buds, which are pointed, and leaving the young fruit-buds or embryo figs, which are round. Careful gardeners in our own country likewise perform most of their pruning in this neat and easy way.

FIGWORT,—botanically *Scrophularia*. A genus of plants, constituting the type of the natural order Scrophularinæ or Scrophulariaceæ. This order comprises a large part of the Didynamia Angiospermia of Linnæus; and is closely allied to the gesneriaceous, the verbenaceous, and the bignoniaceous orders. Its most prominent characteristics are its didynamous stamens and its capsular fruit. A few of its species are shrubs, but most are herbs, and a large proportion of these have opposite leaves. Its species variously inhabit almost all sorts of situations in nearly all the principal divisions of the world; and those at present within Great Britain amount to upwards of 40 stove species, about 120 greenhouse species, 3 or 4 hardy ligneous species, and about 400 hardy herbaceous species, and are distributed into 59 genera. The flowers of some of the genera are personate, or have the palate so large as to occupy or cover the whole mouth of the corolla; and those of others are ringent, or have the palate open. Some, such as the calceolarias, the pentstemons, the antirrhinums, the foxgloves, the linarias, the louseworts, the mimuli, the alonsoas, the collinsias, the schizanthuses, and the veronicas, are highly ornamental; but the greater number have an uninteresting appearance, and never rank otherwise than as mere weeds. A few have pleasant odours or tastes; but the vast majority are malodorous, bitterish, acrid, and generally disagreeable. A small number of species are variously and gently medicinal; and *Digitalis purpurea* is one of the most powerful drugs in the materia medica.

Four species of the genus scrophularia grow wild in Britain; between 40 and 50 have been introduced from foreign countries; and 8 or 10 more are known. Two of the introduced species are evergreen under-shrubs; and most of the others are hardy perennial-rooted herbs. One of the indigenous species, and three or four of the introduced ones have a somewhat ornamental character; and all the others are interesting only or chiefly to amateur botanists. We shall, partly for their own sakes and partly for sake of illustrating the whole order, take brief notice of the indigenous species.

The knotty figwort, *Scrophularia nodosa*, grows wild in woods and under hedges in many parts of Britain. Its root is perennial and spreading, and comprises many whitish knots or knobs, which are alluded to in the name "knotty;" its stems are several, quadrangular, and usually between 2 and 3 feet high; its leaves are opposite, cordate, serrated, dark green or brownish above, and paler green below, and have an odour similar to that of the leaves of elder; its flowers are monopetalous, similarly shaped to labiate flowers, and of a dark purple or blood-red colour, —they come out in small clusters on opposite sides of the stems, and form a kind of loose spike to the top—and they usually bloom in June or even from May till July; and its fruit are roundish capsules, ending in acute points, and having two cells filled with small seeds. This plant was formerly used as a remedy for scrofula, and it thence obtained to itself and to the whole genus the name of scrophularia; and though now little used in medical practice, it retains its place among the materia medica of our colleges, and has some reputation as a diuretic, as a sedative, and as a foment to piles, malignant tumours, cutaneous eruptions, and spreading ulcers.

The aquatic figwort, *Scrophularia aquatica*, grows wild by the side of ditches and in other watery situations, in most parts of Britain. Its root is perennial and fibrous; its stems are strong, quadrangular, and usually about 4 feet high; its leaves are cordate, rounded at their points, and crenated in their edges, somewhat like those of betony, so as to have frequently occasioned the plant to be called water-betony; and its flowers are larger and somewhat redder than those of the knotty figwort, but have the same shape, and appear at the same time. This species shares the medicinal reputation of the preceding, particularly as a remedy for scrofula. A variety of it with variegated leaves is sometimes allowed a place in the flower garden.

The balm-leaved figwort, *Scrophularia scorodonia*, grows wild on the banks of some rivulets and in other watery situations of some parts of Britain, but is very rare. Its root is perennial; its stems are usually about 3 feet high; its leaves are acrid and poisonous; and its flowers are purple-coloured, and bloom in July and August. This species also has the reputation of being a remedy for scrofula; its leaves are used as a foment or poultice for piles; and its juice is used as the chief ingredient of an antiscorbutic ointment.

The yellow or spring fig-wort, *Scrophularia vernalis*, grows wild in moist shady situations in some parts of Britain; but is also rare. Its root is biennial; its stem is usually about two feet high; and its flowers are yellow-coloured, and bloom from March till May.

FILAGO. A genus of herbaceous plants of the thistle division of the composite order. Five indigenous and eight imported species occur in Britain; but all, with only one exception, are usually classified as a subgenus of gnaphalium. Most are annuals; and the rest are perennial-rooted. They have white, soft, woolly leaves,—and when broken, yield cottony filamentous fibres; and hence they are popularly called cuds weeds, cotton-weeds, and cotton-roses.

FILARIA. A genus of minute parenchymatous worms, of the class sterelmintha and order nematoneura of animals. The number of species comprised in it is not ascertained; and all the known kinds of it are included by some naturalists in the genus strongylus. The whole class of intestinal parasites to which it belongs continues to be a subject of much debate and research on the part of zoologists; and though popularly called worms, have been fully ascertained to possess none of the characteristic properties of either the annelida or any other class of articulated animals. All the natural history of the entire class, but especially the history of their propagation as intestinals, or of the manner in which they find their way into the inner organisms of the animals within whom they subsist, is exceedingly obscure. "We can only suppose that their eggs or germs of great minuteness must exist in some form at present unsuspected, and in a dormant state, and be received into the alimentary canal, where some become developed, and there remain, while others are taken up by the lacteals, and carried ultimately into the circulating system, where again some develope themselves, while others are carried to various organs, as the brain and liver, in which they meet with a suitable nidus for their perfection, and where, supplied with abundant nutriment, and fostered by the animal heat, they grow inordinately."—[Knight's Pictorial Museum.]

The several species of filaria have the appearance of small pieces of exceedingly fine thread; and, either by themselves, or in company with other intestinal parasites, they infest various cavities and organs of horses, oxen, and other domestic animals. One or more species accumulate in vast numbers in the bronchial passages of cattle suffering under certain violent yet common kinds of bronchitis; another species congregates and forms tumours near the pyloric extremity of the stomach of oxen; and another inhabits many parts of the great cavity of the horse and the mule, and even in many instances takes up its abode in their eye. The last of these is peculiarly curious, and is noticed as follows by Blaine: "The existence of species of filaria which penetrated the cavities of the body of the horse and his congeners, pervaded its cellular tissues, and even occasionally made its way into the eye, has been long known to those at all conversant in natural history; but that its penetration of the eye was now become one of its settled habits in India, where it resolved itself into an established disease, was not so well known; and the first notices recorded were so vague and indefinite, that I deferred any mention of it, until it assumed a less questionable shape. Through the medium of that excellent source of information, 'The Veterinarian,' we are now more fully informed on the existence of this new proof of the extensive diffusion of parasitic animals over and within every part of the animal frame. It would appear, by notices in the French works, that the filaria is almost as common among oxen and cows in the provinces, as it is among the horses of India. No accounts of its infesting the remnants of the last have, I believe, reached us. This parasite is supposed to be the *filaria papillosa*, and is described as nearly an inch in length; the body elongated and cylindrical; in size and colour corresponding with the finest white sewing thread, but with a semi-transparent lustre; attenuated at either extremity. Its presence is detected by its effects, which are that of a deep-seated ophthalmia, usually confined to one eye only. The conjunctive coat is highly inflamed, and turgid with red blood; the transparent cornea is obscured and cloudy; impatience of light, and closed eyelids are also accompanying symptoms of the irritation. By attentive observation this minute filamentary worm is seen floating within the aqueous humour; and although its presence does not appear to occasion acute pain, yet if it be suffered to remain many days, it is invariably fatal to the eye. Its removal is effected by penetrating the cornea in some part. As soon as the puncture is made, the worm usually escapes with the aqueous humour; and if it should not, the operation must be repeated the next or following day, by which time the eye will have filled again and brought to view the worm also. A slow recovery follows the departure of the parasite; and the opacity occasioned by it is sometimes not wholly absorbed in less than six months."

The filariæ have been ascertained, also, to infest at least forty genera of insects, principally of the coleopterous and lepidopterous orders; and are supposed to attack them in their larval state, to grow with the growth of the larvæ, and even to pass through their transmutation into perfect insects, and to escape only when the latter die. The Rev. F. W. Hope, in a paper read to the Natural History Section of the British Association in 1837, says, "Filaria, as a genus, appears to be the receptacle for several doubtful vermes; and, as it now stands, comprehends under it very anomalous forms. I suggest that the term filaria be restricted to the *filaria medenensis*, or guinea-worm and its congeners, while several other subgenera may be formed to include the parasites infesting insects. It has long been to me a subject of regret that, in our numerous zoological works, frequent descriptions of the guinea-worm have appeared, and not one syllable respecting our British parasites. In short, we pass over those species which are repeatedly found in our own country, and are met with in our collections. We prize too highly the giant forms of all other countries, and place a value on exotics, when equally interesting are those which are indigenous; and not last, not least among them, our long neglected parasitic filariæ."

FILBERT,—botanically *Corylus Avellana*. The cultivated and exotic varieties of the wild hazel. All are hardy small nuctiferous trees, of the amentaceous order, usually varying in height from 6 to 12 or 14 feet. They grow more erectly than the wild hazel, have a different form of stipulæ, produce much more elongated nuts, and cannot easily or at all be made to interchange characters with it from sowings, and are therefore regarded by some cultivators as specifically distinct from it; yet, from the time of Linnæus downwards, they have been treated by the great majority of botanists as strictly varieties of it. Loudon enumerates ten varieties of *Corylus Avellana;* and exhibits six of these, the common filbert, the white filbert, the red filbert, the great cob, the clustered, and the frizzled, as indigenous; and four, the Barcelona, the variegated, the ovate-fruited, and the dwarf, as importations from Spain;—and other writers and framers of catalogues, enumerate so many as about thirty varieties of the species. But Rogers pronounces most of the varieties worthless for the purposes of fruiting; and he treats the great cob and the Barcelona as only one variety, mentions also the Cosford nut, and enumerates in addition only the red filbert, the white filbert, and the frizzled filbert; and this writer thinks, too, that "though filberts and other varieties of the hazel have long been cultivated in Britain, it is more than probable they came to us through Holland."

The common filbert, the white filbert, and the red filbert usually grow two or three feet higher, and the dwarf filbert two or three feet lower, than the other varieties; but all flower in spring, and are nearly simultaneous in the maturing of their fruit.—The great cob or Barcelona nut was introduced to Britain from Spain, in the 17th century, by John Ray. It seems to be a profuse bearer in its native country, and is said to have annually produced from a single plantation 60,000 bushels for shipment at Barcelona; but, in consequence perhaps of its usually being planted in too rich a soil, it is far from being prolific in England.—The white filbert is extensively cultivated on strong loamy soils, incumbent upon dry gravelly subsoils, in the district of Kent around Maidstone; and it is exceedingly prolific, and produces well-flavoured fruit. Its yield of fruit per acre averages about ten or twelve hundred weights; and, in very favourable seasons, has sometimes amounted to upwards of a ton.—The red filbert is not so prolific as the white, but has the reputation of producing the best flavoured variety of fruit. Its leaves, especially when fading, have a reddish green colour; and the kernel of its fruit is coated with a red film; and from both of these characters, it takes its designation of "red."—The frizzled filbert is prolific, but does not equal the white or the red in the flavour of its fruit. The frizzledness alluded to in its name occurs in the leaves of its involucre.—The Cosford nut bears well, and has excellently flavoured fruit. Its shell is thin.

Filberts have long been very extensively cultivated in some parts of Italy, and in the district of Kent around Maidstone. The principal Italian plantations originated the specific name *Avellana*, from the district in which they are situated; and they annually produce nuts for exportation to the value of about £11,000. The Maidstone plantations cover hundreds of acres, and are believed to be a very profitable department of rural economy. The most suitable soil is rich hazel loam; but it ought both to be dry, and to be seldom and slightly, or not at all, touched with manure. The cultivators train the trees to a dwarfed habit, and endeavour to entice their whole strength into the production of flowers and fruit. The young plants are obtained from layers of two or three years' duration; each has one strong erect shoot of at least three feet in height; this shoot is cut down, early in the spring after planting, to the height of about 18 inches; a clear stem of 12 inches is maintained in the lower part, and eight or more vigorous branches are coaxed out of the upper part, either by immediate growth or by a second pruning; the branches are trained outward and upward, so as to commence horizontally and terminate vertically; the tops of the branches are allowed to attain the height of about six feet, and all the middle and lower parts of them are kept free from shoots; so that a fully trained plant has the outline of a cup or chalice. Trees are maintained in a prolific condition, and in their originally trained form, by means merely of the knife, during twenty or even thirty years. The plants are grown either in rows or in quarters; and they stand at distances of from 7 or 8 to 10 or 12 feet, according to the richness of the soil. "The practical example set us by the Maidstone pruners," remarks Rogers, "confirms two very essential principles in the art of gardening, viz. that by counteracting the natural tendencies of a plant, it may be dwarfed, and by thus dwarfing, making it more fruitful. The filbert tree is so constituted, that it is ever extending itself by throwing up a multiplicity of suckers, which exhaust the bearing branches and render them sterile; but denying the plant its tendency to increase itself by suckers, promotes its energy to increase itself by seed."

Filbert nuts intended to be preserved for a considerable time ought to remain on the trees till their husks become yellow or brownish yellow,—to be gathered when dry,—to be spread out on a table or floor, in a warm dry place, without exposure to draught or to much air or light,—to be removed to a still drier place in the event of any of them becoming damp or mouldy,—to be kept spread out till all their moisture disappears and their husks become brown,—and to be then stored in jars and kept in a close dry room till they are wanted. Nuts thus treated will look as fresh, and be in all respects nearly as good, at the end of a twelvemonth, as when they were gathered.—Filbert plants of different varieties may, in consequence of the diversified tints of their leaves and the general character of their form and outline, be appropriately introduced to extensive ornamental shrubberies.—*Loudon's Hortus Britannicus.—Rogers' Fruit Cultivator.—The Gardener's Receipt Book.—Marshall on Planting.—Miller's Gardener's Dictionary.—Mills' Husbandry.*

FILICES. See FERN.

FILIPENDULA. See DROPWORT.

FILLER, or THILLER. A horse yoked immediately to a cart, and supporting the shafts.

FILLY. A female colt or young mare.

FILMY-LEAF, or FILMY-FERN,— botanically *Hymenophyllum.* A genus of ferns of the polypody tribe. The Tunbridge species, *Hymenophyllum Tunbridgense*, grows wild on moist rocks, on wet rocky hills, and in moist shady places in Britain and in most other countries of Europe. Its roots are long, slender, wiry, smooth, and creeping; its stalks are wiry, and 3 or 4 inches high; and its fronds are erect, smooth, pellucid, and filmy, curl up in drying, and constitute one of the most elegant objects in the vegetable kingdom. Wilson's species, *Hymenophyllum Wilsoni*, is similar in habitat, height, elegance, and general character to the preceding. Many exotic species are known to botanists; and the genus, as a whole, is celebrated for its beauty. Plants of our two native species may be grown in pots, and readily propagated by division of the roots.

FILTER. An apparatus for purifying a liquid from any foreign matters which it holds in mechanical combination but not in solution. Tinctures, infusions, and other classes of medicinal liquids, are usually filtered in a very simple manner, through unsized paper, spread within a conical funnel; and chemical liquids of great nicety of character are filtered by various kinds of apparatus peculiar to the laboratory. Water is the principal liquid requiring filtration upon a farm; and this, in many instances, requires it on a very large scale. Many a cottage and even many a farm depend upon the catching and storing of rain water for much of the supply of both the kitchen and the live stock; and all such ought, for the sake of both health and cleanliness, to be provided with some filtering apparatus. The average annual fall of rain, in many districts, upon 100 square feet of surface, is about 1,400 gallons; and this, when collected from the roof of a cottage, and carefully preserved in a tank, has been found sufficient for all the uses of a cottier's family; and, when collected from the roof of the numerous and extensive roofs of a farmery, might go far to supply the large demands of even a farm-yard.

An exceedingly cheap and simple, and at the same time quite efficient, filter for cottage use, may be made of a flower-pot, a piece of sponge or some washed sphagnum, some clean silicious sand, and a few small bits of charcoal obtained by the burning of a billet in a slow fire. "Take the flower-pot, and put either the sponge or the washed moss over the hole at the bottom; fill the pot three-fourths full of a mixture of equal parts of the sand and the charcoal,—the latter broken into pieces about the size of peas; on this lay a piece of linen or woollen cloth, large enough to hang over the sides of the pot; pour the water to be filtered into the basin formed by the cloth, and it will come out pure through the sponge in the bottom. The cloth must be frequently taken out and washed, as must the sand and charcoal, and the piece of sponge or moss in the bottom. The larger the pot, the more complete will be the filtration."

A simple and cheap filter on a somewhat large scale, such as is required for a large dwelling-house or for a farm-yard, may consist of a deposit of flannel, sand, and charcoal in one of two casks, of two, three, or four feet in height, and of any convenient diameter. "One of the casks may receive the water from the roof, or from any other supply; the other should have a false bottom, perforated with holes, and covered with flannel; on this flat bottom equal quantities of sand and charcoal may be laid to the depth of 12 or 14 inches, and covered with another false bottom similar to the first; the remainder of the cask will contain the filtered water, which may either be drawn off as wanted by a cock, or allowed to pass into an underground tank by the same means. The grosser impurities will always be deposited at the bottom of the filtering tank, and these may be drawn off at pleasure by a cock, placed immediately above the bottom of the barrel. The sand and charcoal may also be freed from any impurities which they may contract, by first allowing both barrels to be quite full, and then turning the bottom cock, in consequence of which the filtered water will descend through the filter and clear it. The advantage of having two barrels for the purpose of filtering the water from a roof is partly to retain a larger quantity on the supposition that there is not a reservoir or tank under ground, and partly to admit of supplying the first barrel, from ponds or other sources, in seasons when the roof is unproductive. Where the water is to be preserved in a tank under ground, only one barrel is necessary, the pipe from the roof proceeding, in that case, at once to the bottom of the filtering barrel, and entering where, in the case of two barrels, the junction-pipe enters." [London's Encyclopædia of Agriculture.] When impure water is drawn from a pond or stream to a lower level, it may be filtered during its descent by being made to pass through a duct or gorge filled with charcoal, sand and gravel.

FIMBLE-HEMP. See Hemp.

FIN. The cutting-plate on the coulter of a plough.

FINCH. This numerous class of birds embraces not only some of the most beautiful, but also the most agreeable of the feathered tribe. It forms the genus *fringilla* of Linnæus, which has since been much subdivided by modern ornithologists.

The canary bird (*F. canaria*) is the most remarkable and melodious of the finch tribe: and, next to the nightingale, has been most celebrated for its musical powers. In a wild state, it is chiefly found in the Canary islands, but has become so common in a state of captivity, that its native habits and country have been almost forgotten. It is uncertain at what period these birds were introduced into Europe, but probably not till about the 14th century. Belon, who wrote in the 16th, makes no mention of them. Gesner and Aldrovandus speak of them as so great rarities, that they could only be purchased by people of high rank. They are now bred in great numbers, and have become so common that they are of little comparative value. Buffon enumerates 20 varieties; and many more might probably be added to the list, were all the changes incident to a state of domestication carefully noted. In their native state, they are of a dull and uniform green, and exhibit none of that richness and variety which are so much admired in the tame ones. Like the rest of the finch tribe, they have a high, piercing note, which they continue for some time, in one key, without intermission, then raise it higher and higher by degrees. This note is variously improved by education; for this bird, being more easily reared than most others, and continuing its song much longer, has had much attention paid to it. Numbers of treatises have been written on the rearing and education of these birds, which we have not space to analyze. Let it suffice, that in Germany and the Tyrol, from whence the rest of Europe is principally supplied, the apparatus for breeding canaries is both large and expensive. A large building is erected for them, with a square space at each end, and holes communicating with these spaces. In these outlets are planted such trees as the birds prefer. The bottom is strewed with sand, on which is cast rape-seed, chickweed, and such other food as they like. Throughout the inner compartment, which is kept dark, are placed brooms for the birds to build in, care being taken that the breeding birds are guarded from the intrusions of the rest. Four Tyrolese usually take over to England about sixteen hundred of these birds; and, though they carry them on their backs, nearly 1,000 miles, and pay 20 pounds for them originally, they can sell them at five shillings each.

Linnet (*F. linaria*). This plain, but melodious little bird is common to all parts of Europe. It is about five inches and a half in length, of a dark reddish-brown colour on the upper parts, and a dirty reddish-white beneath. It builds its nest in low bushes: the outside is made up of dried grass, roots and moss, lined with hair and wool. The female lays four or five eggs, of a pale blue colour, spotted with brown at the larger end, and generally breeds twice in the year. The song of the linnet is sweet and varied; its manners are gentle and docile; it easily adopts the song of other birds, when confined with them, and, in some instances, has been taught to pronounce certain words. It is frequently found in large flocks, and, during winter, feeds on various kinds of seeds, but more particularly on the lintseed, from which circumstance it derives its name.—Two other well-known species are noticed in the articles GOLDFINCH and BULLFINCH.

FINE-BENT. See AGROSTIS.

FINGER-GRASS. See DIGITARIA.

FINGERS-AND-TOES. See ANBURY.

FINOCHIO. See FENNEL.

FIORIN,—botanically *Agrostis Stolonifera Latifolia*. A variety of indigenous, aquatic, agricultural grass, of the bent genus. Its roots are perennial and fibrous; its stems are decumbent and stoloniferous; its leaves are soft, silky, and very narrow; its panicles are somewhat contracted, and have slightly hairy branches, and spreading branchlets; and its lower paleæ are five-nerved and awnless. Its roots penetrate but a short distance into the soil, and have none of the knotted and vivacious character which distinguishes those of black couch, and its stolons grow out in the manner of the side-shoots of strawberry-plants, and are exceedingly numerous and prolific, and multiply the grass with great rapidity.

This grass, in common with many other of the bents, was at one time known only as a weed; but, nearly thirty years ago, it was introduced to notice as an agricultural grass by the Rev. Dr. Richardson, of Clonfeacle, in the county of Antrim, in Ireland; and from that time till a few years ago, it was a subject of great controversy among cultivators,—one party, headed by Dr. Richardson, contending that it was the very best known grass for meadow purposes, another party contending that it was as mere a weed and almost as mischievous as common black couch, and a third and increasing party pronouncing it a good enough grass for some situations and quite a useless one for others. Three great recommendations of it, on the part of its admirers, are, that it grows luxuriantly on low and swampy grounds which will not produce any other kind of valuable herbage,—that it yields enormous crops on irrigated meadows,—and that it vegetates during such large and cold portions of the year as to be available for green fodder throughout the greatest part of winter. It certainly succeeds well on the peculiar boggy grounds, with moist substrata and a humid atmosphere, where it grows indigenously in Ireland; it unquestionably was produced by Dr. Richardson and some of his imitators in quantities and in seasons and circumstances which utterly astonished well-informed agricultural observers; and it no doubt grows with more or less vigour from the beginning of October till the end of March, and is quite capable, in open dry weather, of being made into hay in December. Yet some of the most sanguine of its early advocates, including Dr. Richardson himself, eventually discovered that they had greatly over-estimated its value; and others continued to talk of it in a style of such wild and raving eulogy as indicated their seeing it no longer through the judgment, but wholly through the imagination. "Some of the Doctor's pupils," we are told, "went to the length of asserting that, though this grass succeeded best on reclaimed bog, it produced very heavy crops on dry, upland ground, and that, if unmown at the proper season, autumn, and allowed to stand over during the winter, it neither rotted, nor lost any of its good qualities, and became a substitute for turnips, mangel-wurzel, or rape."

Fiorin seems to require a soil of a free and porous texture, with much peat in its composition, and kept in constant irrigation by infiltration from the sides of rivers, brooks, draining ditches, or other streams, but not by overflooding, nor even by infiltration from lakes, canals, or stagnant ditches. One reason, therefore, why it has utterly failed or but poorly succeeded in the experiments of English and Scottish cultivators, may be that damp marshy soils of any description, and particularly marshy soils of firm texture, or with retentive subsoils, or with stagnating water, have been used for putting it to the test. But it probably requires also a very humid atmosphere, and may, on that account, be highly suitable for the constant fogs and drizzle of the Irish marshes, and just as unsuitable for the dry and clear air of the English meadows. Yet even when soil, climate, and all other circumstances are favourable to it, and when it grows in such luxuriance as considerably to justify the extraordinary eulogies of its most zealous advocates, it is still encumbered with three rather serious disadvantages, —it lies in so decumbent and matted a manner as to be very difficult to mow,—it becomes ripe for the scythe at so very advanced a period of the year as not to be easily made into hay,—and it contains, in proportion to its bulk, a much smaller amount of nutritive matter than some of the other and more facile aquatic grasses. It is beyond all question a very valuable meadow-grass in the particular parts of Ireland where it grows spontaneously, or is easily and abundantly propagated; but it no longer claims superlative excellence, or demands the exclusive occupancy of meadow-land, in even the most favourable of these parts; and it by no means possesses general adaptation to the meadows of Great Britain, yet may with good effect be propagated in some of the peaty marshes of our western sea-board. Many of the conflicts of opinion respecting it, and a large proportion of the condemnations of it, have arisen from confounding it with some of the hard and utterly worthless varieties of bent. See the article AGROSTIS.

Dr. Richardson sometimes planted the stolons of fiorin on fallow ground, and thus created a meadow; he, at other times, coaxed up a spontaneous growth of it on the kind of flat peaty moist alluvium in which it is indigenous; he scarified the surface of cold, sour, stiff meadows, intersected them with shallow drains, and spread over them a top-dressing of a compost of ditch-scourings and lime or farm-yard manure; and he carefully eradicated all coarse or weedy plants which made their appearance, and did not allow the fiorin meadows to be, at any time of the year, grazed or even touched by cattle. The method of propagating fiorin which he recommended to others, was to cut the stoloniferous shoots into small pieces, to strew them on the ground, to give them a course of rolling, and to use care that the whole operation be gone through in somewhat moist or at least humid weather. "This, however," remarks Mr. Lawson, "is a tedious as well as a precarious operation; and the principal reason given for it by its advocates is the difficulty of procuring seed, and its shyness in vegetating. These objections are, however, groundless; for seeds of this and several other varieties are yearly imported from Germany and France; and all that is found requisite to insure a regular braird, is to have the land in a fine pulverized state before sowing, otherwise the seeds are apt to be buried from their smallness." —*Dr. Richardson's Essay on Agriculture.—Dr. Richardson's Memoir on Fiorin Grass.—Lawson's Agriculturist's Manual.—Doyle's Practical Husbandry.— Sproule's Treatise on Agriculture.— Knowledge Society's British Husbandry.*

FIR, or SPRUCE FIR,—botanically *Abies*. A genus of hardy evergreen timber and ornamental trees, of the coniferous order. Firs were formerly included by all botanists, and are still included by some, in the pine genus; nor do they differ from the true pines in any distinct or permanent character of either flower or cone. Yet all have their leaves solitary, while the pines have them in small groups or fascicles; all have a membranous scaly covering on every bud or unexpanded shoot, while the pines have closely imbricated, chaffy, or feathery scales in connexion with the sheath-enveloped young leaves; and all are further distinguished from a large proportion of the pines by more thinness or foliateness in the scales of their cones, and by having from 3 to 9 cotyledons while the pines have from 4 to 12; and on the strength of these differences, as well as for the sake of general convenience, they seem abundantly worthy of being regarded as quite a distinct group. Even this group, however, has been broken up by modern botanists into the four genera *abies*, *picea*, *larix*, and *cedrus*. We have briefly noticed the general character of these new genera in the article ABIES; we discuss three of the genera respectively in the articles SILVER-FIR, LARCH, and CEDAR; and we limit ourselves in the present article to the genus abies in its restricted sense, as inclusive only of the spruce firs. One prominent, important, and far-diffused timber tree which popular nomenclature ranks with the firs under the name of the Scotch fir, is not a fir at all, but a true pine, and will be noticed in the article PINE.

The common, tall, Norway, or European spruce fir, *Abies excelsa*, formerly *Pinus abies*, is a native of the northern countries of Continental Europe and Asia, and was introduced to Britain about the middle of the 16th century. It abounds principally on mountain declivities and in deep mountain valleys, with a northern exposure, and a humid and rather light soil; and it constitutes, together with the Scotch pine, almost the whole of the natural forests of many districts of Scandinavia and other parts of the cold, temperate regions. Its stem is erect and soaring, and very generally attains a height of from 100 to 150 feet; its branches are short and verticillate, the lower ones drooping, and the middle and upper ones so disposed as to form in the aggregate a regular pyramidal outline; its leaves are sharp-pointed, curved or bent, of a dark green colour, generally less than an inch in length, very narrow, so beautiful as to challenge admiration, and more crowded on the young shoots than on the old branches, and more also on the sides of shoots and branches than on their upper and their under surfaces; its male catkins are cylindrical, generally curved, about an inch in length, and of a yellowish colour tipped with red; and its cones are terminal and pendulous, bright red when young, and cylindrical, five or six inches long, and from 1 to 1½ inch in diameter when ripe.

A tree of the common spruce, when young, feathers to the ground, and has a handsome appearance; but when old and in close plantations, becomes ragged and unsightly; yet in parks, and in a state of protection from cattle, it continues till an advanced age to feather to the ground, and to display its pristine elegance of form. It is picturesque and sometimes very imposing as one of a group of widely diversified trees in a plantation; but it is too formal, too conical, too uniform, too much destitute of every feature of force and intricacy, to make a good figure by itself. It excels as a forest tree on many kinds of ground, but is nearly worthless in some, and of indifferent or doubtful value in others. In damp situations, in hollows, and in ravines among mountains, it grows as rapidly as the larch, and attains a much higher stature than the Scotch pine; but in dry and exposed situations, it makes little progress for six or seven years, and sometimes barely manages to live and become arborescent. It will bear to be much more thickly planted than any other tree; it forms an excellent screen to more valuable trees, and readily submits to the pruning of its lower branches; and it lives with patience for many years under the overshadowing of the Scotch pine, and soars suddenly and vigorously aloft when the latter is removed. "But good as many of the qualities of spruce-firs undoubtedly are, they have also some drawbacks. The close texture of the leaves and branches prevents all ingress to the air, so that no herbage will grow under them, though they can afford complete shelter to live-stock from any storm. Their evergreen branches subject them to the violence of the winter winds, which, unable to tear their powerful fangs out of the ground, snap their stems over from 5 to 10 feet above the ground, thus destroying the value of the tree for timber. Being a tree which pushes out early in the spring, the top shoots of the spruce are frequently hurt by the frost, which is indicated by their assuming a brown tint. This injury checks the growth of the tree till the autumnal rains. With these exceptions, the spruce is certainly a valuable tree to cultivate in our damp and mountainous regions."

The timber of the common spruce is whiter, lighter, less resinous, and more elastic than that of the Scotch pine; and is exceedingly suitable for the masts and yards of ships, and for many kinds of large planking. It is extensively imported to Britain from the Baltic, and bears the names of white deal, white Baltic deal, and white Christiana deal, and is well known to almost all workers in coarse timber for its numerous adaptations and for its properties of elasticity and of never twisting. But spruce timber is very inferior in value when obtained from young trees, and does not exhibit its maximum of excellence except from trees of at least a century old. Young spruce plants, such as those obtained in the thinning of young plantations, are serviceable for posts and rails, and keep free from worms and decomposition as long as young larches, but are of little or no value as working timber. Spruces began to be introduced to the celebrated Dunkeld plantations about the year 1740, and were soon ascertained to be so vigorous as trees and so useful as timber that they were multiplied within the Athole grounds, in groves by themselves, at the rate of from 20,000 to 200,000 in the year. "The great trial of their value as large timber," we are told, "was made in 1805, when the bridge was building over the Tay at Dunkeld. At that time 50 or 60 trees, which stood in the way of a new road, were cut down and sawn into planks of 10½ inches. These trees contained from 70 to 80 cubic feet each of timber, and they were at least 100 feet in height. These planks were mostly used as caissons under the piers of the bridge, and many of them were used as heavy planks, upon which were wheeled earth and stones for twelve years. Planks and posts of spruce were used in the fitting up of the new stables at Dunkeld. Those trees which were cut down for the planks were much branched down to the ground, but in cutting up the timber the effect of these branches was found only superficial, no knots having entered into the wood. For some other spruces that the Duke caused to be felled, he got from 2s. 10d. to 3s. per foot." Young spruce firs serve well as evergreen sheltering hedges; yet they ought to be grown in that capacity only as means of bringing forward more suitable plants of slower growth, for they soon become shanky and bare below. Foreign spruces possess much incidental value for the produce of the Burgundy pitch, the yellow resin, and the white resin of commerce.

The common spruce grows and thrives in soils of very different qualities, but is most luxuriant in deep loams, and succeeds better than any other kind of fir on very moist grounds. It is propagated in the same manner as the Scotch pine, but submits more readily to change when well up, and does not require to be so often removed in the nursery. The seeds should be sown on a north border in March; the seedlings, on making their appearance six or seven weeks after sowing, should be carefully screened from birds; the seedbeds should be periodically weeded in winter, and watered in dry weather; the young plants should be cautiously taken up and planted at intervals of one foot in the nursery ground in next spring; and, after standing there and being kept free from weeds during three years, they may be removed to their final destination; or if very large trees are required, the plants may be transplanted in the nursery at distances of 18 inches from plant to plant and 30 inches from row to row, and allowed to stand there till they attain a height of 6 or 8 feet. In many parts of Continental Europe, where the cultivation of the common spruce has come much into vogue, the seeds are sown on well prepared ground, in the proportion of from two to four quarts per acre, along with a sowing of oats or barley; and after the cereal crop is removed, the young spruces are allowed to grow up where they were sown, and to occupy the ground as a rising forest.

The weeping or pendulous Norway spruce, *Abies excelsa pendula*, is distinguished from the normal plant of the species, by the greater length of its leaves, by the deeper and glossier green of its verdure, and especially by the very drooping or pendulous habits of its branchlets. The variegated-leaved Norway spruce, *Abies excelsa foliis variegatis*, is distinguished by the comparative dwarfishness and compactness of its form, and by the shortness and the yellowish blotchedness of the leaves. These varieties possess no special recommendation as timber-trees, but are sometimes preferred to the normal plant for their ornamental effect in parks and home-grounds.

The black spruce fir, or black American spruce, *Abies nigra*, is a native of North America, and was introduced to Britain in 1700. It abounds most in its wild state on light soils or on cold moist sand between the 44th and the 54th degrees of north latitude; and is most luxuriant and lofty in thoroughly sheltered situations, on deep, black, peaty ground. It usually has a height of only about 50 or 55 feet, but sometimes attains a height of 70 or 80 feet. Its outline is regularly conical; its branches are verticillate, and usually horizontal or somewhat drooping near the base and aspiring toward their top; its bark has a dark dusky colour; its leaves are rigid, straight, abrupt-pointed, angular-sided, dark glaucous green, marked with two silvery stripes on both of their surfaces, scarcely half-an-inch in length, thickly set, and regularly spreading on all sides of the boughs; its male catkins are erect, cylindrical, stalked, yellowish, and about an inch long; and its ripe cones are pendulous, dusky reddish brown, and about an inch and a half in length and three-fourths of an inch in diameter. This tree, when planted in Britain, requires a moist, peaty, or moorish soil, and will not succeed in dry, warm, exposed situations. The tops of its branches yield the best kinds of essence of spruce, for the manufacture of spruce beer. Its young stems and the upper part of its old stems are light, strong and elastic, and are much used in America for the spars and top-masts of ships. Its large roots and the lower parts of its old stems are sometimes used in America as substitutes for oak in making the knees and other bent parts of ships. Its timber, of American growth, is sawn into boards, and exported into Britain and the West Indies for making packing-boxes, herring-barrels, and other similar articles. Its resin is comparatively scarce and poor, and does not suffice for yielding turpentine or fine pitch.

The white spruce fir, or white American spruce, *Abies alba*, is also a native of North America, and was introduced to Britain in 1700. It inhabits the same latitudes as the black spruce, but extends somewhat further north, and dislikes a dry peaty soil. Its height and outline are nearly the same as those of the black spruce; its branches are more horizontal; its bark is not so dark-coloured; its leaves are neither so crowded, so straight, so dark-coloured, nor so abrupt-pointed; its male catkins are pendulous, and of a brown and yellowish colour; and its ripe cones have a light brown colour, and are from 1½ to 3 inches in length, and rather more than one-fourth of that measurement in diameter. Its root fibres are macerated, stripped, and made into cordage by the North American Indians; and its timber is inferior in value and adaptation to that of the black spruce, yet is used for the same purposes.

The red spruce fir, or red American spruce, *Abies rubra*, is a native of Nova Scotia and Newfoundland, and was introduced to Britain in 1755. It is much scarcer than the two preceding species, and has a fondness for cold moist soils. Its height is usually between 30 and 50 feet, and can seldom be coaxed up to 70; its outline is conical or pyramidal; its branches are slender; its bark is reddish-brown; its leaves are slender, sharp-pointed, slightly compressed, finely curved or waved, and of a lively green colour,—and those on the under sides of the branches are aspiring; and its cones have a dusky brown colour, and are intermediate in size between those of the black spruce and those of the white spruce. It was formerly confounded with the black spruce, but is easily distinguishable by several of its features, and especially by the characters of the leaves and the comparative smallness of its size. Its timber has a reddish colour, and is intrinsically better than that of either the black spruce or the white spruce, but seldom can be obtained large enough to serve any of the purposes of bulky timber.

Smith's spruce fir, or the Himmalayan spruce fir, *Abies Smithiana*, is a native of the Himmalaya mountains, and was introduced to Britain in 1818. It has a closer resemblance to the common or Norway spruce than to any of the American species; yet is readily distinguishable by the greater rapidity of its growth, the greater luxuriousness of its appearance, the greater slenderness and droopingness of its branches, and the darker green, greater length, and superior fineness of its leaves. Its height is comparatively lofty; its outline is pyramidal; its bark is light-coloured; its buds are copper-coloured; and its leaves are nearly straight and about one inch and a half in length. It grafts well on the common spruce; and also grows, though rather indifferently, from cuttings.

Lord Clanbrassil's spruce, *Abies Clanbrassiliana*, is a remarkably dwarf species, a mere shrub of usually about 3 or 4 feet in height, propagable only from cuttings or layers, and possessing considerable interest as a curious and outre decoration of shrubberies and pleasure-grounds. It was found, and seems to have originated, on the estate of the Earl of Moira in Ireland, and was introduced to Great Britain by Lord Clanbrassil; and though commonly enumerated as a distinct species, and certainly possessing very distinct characters, it is proved by its unseeding habit and by the circumstances in which it was discovered, to be a mere variety, though an astonishingly sportive one, of either *A. rubra* or *A. excelsa*. "The former of these," remarks Mr. Lawson, "certainly bears the closest approximation to it in size; but the latter resembles it most in the colour of its bark, buds, and leaves, and seems upon the whole most entitled to its relation, notwithstanding the immense disparity in their height and habit of growth. That *A. communis*," *A. excelsa*, "is, however, occasionally liable to accountable variations in its size is ascertained by very dwarf specimens being occasionally found in plantations, although enjoying similar advantages with the rest; and in the Edinburgh Royal Botanical Gardens are several varieties, the produce of seeds procured from native forests on the Continent, which are nearly as dwarf in their habit of growth as *A. Clanbrassiliana*. The same unaccountable variations also occur in black and white spruce plantations."

The oriental spruce fir, *Abies orientalis*, is a native of the Levant, and was introduced to Britain in 1825. It usually attains a height of about 30 or 35 feet.—The Carpathian spruce fir, *Abies carpatica*, is a native of the Carpathian mountains; and usually attains about the same height as the black and the white spruces.—The pitch spruce fir, *Abies Pichta*, is a native of Siberia, and was introduced to Britain in 1820. It holds a doubtful place between the true spruces and the silver-firs, yet is probably more allied to the latter than to the former; and it usually has about the same height as the American spruces.—The Roman spruce-fir, *Abies Romana*, is a native of the South of Europe, and was introduced to Britain in 1820. It also holds a doubtful place between the true spruces and the silver-firs; but it usually has only about four-fifths of the height of the pitch spruce.—*Loudon's Works.—Lawson's Agriculturist's Manual.—Watson's Forester's Manual.—Gilpin's Forest Scenery, by Sir Thomas Dick Lauder.—Nicol's Planter's Calendar.—Marshall on Planting.—Transactions of the Highland Society.—Quarterly Journal of Agriculture.—Knowledge Society's Useful and Ornamental Planting.—Miller's Gardener's Dictionary.*

FIRE. See COMBUSTION.

FIRE-BLAST. A shrivelled and greatly diseased state of the lower leaves of hop-plants. It usually occurs after a rapid succession of hot sunshine and cooling showers in July; and sometimes affects only small portions of a crop, but at other times scorches all or almost all the plants from side to side of a hop-ground. It seems to be ill understood as to either its causes, its nature, or its cure; and figures in the same indefinite manner as blight of cereal crops; and greatly demands searching scientific investigation. See the article HOP.

FIRE-BOTE. A bundle or heap of fuel.

FIRE-FANGING. See FARM-YARD MANURE.

FIRE-BRICKS. See BRICKS.

FIRING, or CAUTERIZING. The application of the cautery or white-hot firing-iron to diseased parts of the bodies of domestic animals, particularly of the horse. It is a severe and very painful practice; and, in consequence of having been much abused or unnecessarily resorted to by bungling and cruel practitioners, it has fallen into considerable disrepute; but it really exerts great therapeutic power as a counter-irritant, and ought, when wisely conducted, to be held in much esteem. The iron is usually so applied to the skin as to burn without penetrating it; and it then excites an inflammation so sudden and violent as to rouse the absorbents into energetic action, and sometimes to disperse callous or even bony tumours. The diseases in which it is most efficacious are spavins, ringbones, and old swellings about the back-sinews resulting from strains and windgalls. But firing is used also as a styptic, for arresting bad hæmorrhages; as a caustic application for searing the buds of farcy, for stopping the flow of synovia in open knee-joint, and for some other surgical purposes; and as an economical appliance, for corrugating a cinctural piece of skin, and making it act as a bandage on the subjacent parts; and, in the last of these capacities, it has been recommended for the purpose of strengthening the back-sinews and hocks of colts, in order to prevent strains and what is popularly termed breaking-down. But though the use of it as an economical appliance, is plausibly argued for on scientific principles, and very extensively sanctioned by practice, "it is difficult, if not impossible," as White wisely remarks, "to conceive how the workmanship of the Deity can be improved by such means;" and even in cases in which it unquestionably possesses high power for the reduction of tumours and other unhealthy growths, it ought, in common sense and in ordinary humane feeling, not to be practiced till milder counter-irritants have been tried and proved unavailing. The Arabs use the firing-iron as a sort of panacea for horse diseases; and only such Britons as are akin to them in moral nature will follow their barbarous example. Winter distributes firing into three kinds or degrees; the first, superficial firing, which he pronounces to have scarcely a stronger counter-irritant action than a good blister, with the disadvantage of inflicting a permanent blemish; the second, mediate firing, which produces a contractile effect on the skin, and endows it with a bandage-like power; and the third, deep firing, which penetrates the skin, enters the cellular tissue, and renders the benefits of the two preceding kinds permanent. But most other veterinarians deprecate the penetrating of the skin; and all insist on the propriety of having the firing-iron rounded on the edge and perfectly clean.—*Winter.—White.—Blaine.—Youatt.—Gibson.*

FIRING-IRON. See CAUTERY and FIRING.

FIRKIN. A measure of capacity. A firkin in English beer measure is equal to one-fourth of a barrel; and in London, it contains 9 gallons,—but in many parts of the country, only 8½. A firkin of butter, in Irish provision measure, must contain at least 56 lbs.

FIRLOT. A Scottish dry measure. It is equal to one-fourth of a boll, yet varies very considerably in capacity. Three different firlots, used in some districts, bear the proportion to one another of 21, 25, and 31. The wheat firlot of Linlithgow is to the imperial bushel as .998 to 1; and the barley firlot as 1.456 to 1. The firlot of Mid Lothian for wheat, rye, and pulse is equal to 1.0218 Winchester bushel; and the firlot for oats, barley, and malt is equal to 1.4904 Winchester bushel.

FIRST FRUITS AND TENTHS, in law. First fruits are the profits of every spiritual living for one year; and tenths are the tenth of the yearly value of such living, given anciently to the pope, throughout all Christendom, but, in England, by statute 26 Henry VIII., c. 3, transferred to the king. By statute 27 Henry VIII., c. 3, no tenths are to be paid for the first year, as then the first fruits are due; and, by several statutes in the reign of Queen Anne, benefices under £50 per annum shall be discharged of the payment of first fruits and tenths. She also restored the profits of this revenue to the church, by establishing a perpetual fund therefrom, vested in trustees, for the augmentation of poor livings under £50 a-year. This is called *Queen Anne's bounty*, and is further regulated by subsequent statutes.

FIR-TREE. See FIR.

FISHES. One of the four great classes or primary divisions of vertebrated animals. A systematic view of them, no matter how brief, would exceed the limits which we could afford to it, and is foreign to the design of our work. They are animals which live in the water, with red, cold blood, with cartilages or bones, with fins instead of limbs, and which inspire and expire air, in combination with water, by means of gills, instead of lungs. They can live but a short time out of the water, although eels have been seen on land. According as fishes have cartilages, or a bony structure, they are divided into two general classes. The cartilaginous fishes either have or have not a gill-cover. To the latter kind belong the lamprey, the ray and the shark; to the former, the sturgeon, the porcupine-fish, the sea-needle, the eel and the sword-fish. The bony fishes are divided into orders, according to the position of the ventral and thoracic or pectoral fins. In the eel-pout, the Baltic dorse and the haddock, the ventral fins are placed before the pectoral; they are directly under them in the bream, the perch, the perch-pike, the mackerel, and the river-perch, and behind them in the salmon, the pike, the herring, and the carp. In the structure of fishes, the fins are remarkable as being the only organs of motion. They consist of bony rays, covered with the epidermis, and attached to certain cartilages or bones which are moved by particular muscles. The tail, with its fin, serves as a rudder, to give the proper direction to the motions of the animal. The first impulse in swimming evidently comes from the tail; the other fins serve to regulate the position of the fish, and to guide him in his different motions. The eel, which has no ventral fins, swims like water-snakes, by moving his whole body in an undulating manner. The muscles of fishes must be distinguished from the fleshy muscles of warm-blooded animals. They consist of white or light coloured layers, with fibres of a thicker texture than those of warm-blooded animals; between these layers there is a white, gelatinous substance, which grows putrid very soon after death. If we look at the organs of sense and the nervous system in fishes, we cannot but remark the extraordinary smallness of the brain in proportion to the size of the body. In man, the brain is 1-23 of the body; in the shark, it is 1-2500, and in the tunny-fish, 1-37,400; it is also less solid than in warm-blooded animals, and consists mostly of lumps resembling ganglions. The cerebellum is only a transverse plate, entirely without the structure, which, in higher orders of animals, is called *arbor vitæ*. The nerves of fishes are weaker than those of the higher animals; some of them, however, are such powerful exciters of electricity, that they can give violent shocks; but the power ceases as soon as the nerves are cut. The torpedo, the gymnotus, the electric eel, the Indian-needle, and the electric porcupine-fish, are five fishes which appear to be living Voltaic piles; for they have two muscular piles, separated from each other by a membrane resembling a net, and which, at least in the torpedo, lie under the curved cartilages of the large side fins, and are regulated by particular nerves. As to the organs of sense in fishes, those of smelling and seeing appear to be the most perfect. Fishes smell the bait farther than they can see it, and the shark perceives at an incredible distance the odour of a Negro. Their organs of smell have no connexion with those of respiration; and the water apparently conveys the effluvia affecting the sense of smell much less perfectly than the air; but they have very large olfactory nerves, the ends of which were for a long while taken for the true brain. As to their organs of sight, they have very large eyes, but generally no eyelids; but the epidermis goes directly over the eye, and in the blind-fish appears to have only a slight transparency. The cornea is very flat; immediately behind it usually is the crystalline, which can protrude even through the pupil, so that there is very little room for the aqueous humour. The crystalline of fishes, on the other hand, is nearly spherical, and also of a greater density than that of land animals; it is apparently moved by an organ in the shape of a fan, which proceeds from a knot of several optic nerves. The iris is generally of extraordinary brilliancy, and of a beautiful red or gold colour; the vitreous humour is very small. The organs of hearing are less perfect, although this sense cannot be entirely denied to fishes. Only cartilaginous fishes have an external auditory passage, as the shark and the ray; the fishes with bones are without this external ear. All of them have three winding tubes in their head, which terminate in a bag filled with nervous marrow, and containing three hard bones. This constitutes the whole organ of hearing. That of taste seems to be still more imperfect. Their tongue has not even the papillæ, and the nerves are branches of those which go to the gills. The respiration of fishes is carried on by means of their gills; these are well known to be vascular membranes, four on each side, fastened to a curved and flexible cartilage. They are connected with the cartilages of the tongue, and with the cranium. In cartilaginous fishes, the gills are within the body like bags, and a determinate number of external openings lead to them; the lampreys, and that kind called the *nine eyes*, have seven, rays and sharks five of these openings. Several fishes have also a peculiar covering for the gills, and frequently a membrane over them, which can be contracted or extended. It encloses a number of winding cartilages, which are called its *rays*. The gills, as is very evident, can only receive the air which is mixed with the water. What is called the *air-bladder* is, in most fishes, joined by an air-pipe to the stomach or throat. This is thought to contain nitrogen; but it is certain that it assists their rising in the water. Several fishes, as the loach and gudgeon, breathe also through the excretory duct, as is fully proved. The ling are even discovered when at the bottom of the sea, by the rising of air bubbles. Fishes commonly have no voice; but the fatherlasher, the loach, the trout, and some others, give, when pressed, a murmuring sound, in doing which they seem to make great efforts, and tremble all over their body. It is very probable that this sound is produced by the air, violently pressed out of the bladder. The circulation of the blood in fishes is, as might be expected, different from that of the higher classes of animals. The heart consists only of one auricle and one ventricle; it receives the blood from the body, and sends it, by a single artery, directly to the gills; it is here provided with oxygen by contact with water, and the air contained in it, and is again received by a number of small vessels, which flow together into the aorta, which distributes the blood over the whole body. The motion of the heart is, in fishes, much more independent of the brain and spinal marrow than in the higher orders, and, for this reason, can continue several hours after the brain and spinal marrow have been destroyed. The chyle produced by the digestion of fishes is received by absorbing vessels, which terminate immediately in the veins, without going through glands. Although most fishes lay eggs, which are matured and hatched out of their body, there are cartilaginous fishes which are viviparous. That there are hermaphrodites among fishes has been lately proved; for Home has found in lampreys both spawn and milt. The productive power of fishes is greater than that of any higher animal. In the spawn of the tench there have been counted 38,000 eggs at once; in that of the mackerel, 546,000; and in that of the cod, 1,357,000. The beauties of their form, the wonders of their organization, their minute and diversified adaptations to their liquid element, and the myriads of illustrations which their structure and habits afford of the wisdom and beneficence of the Creator, are fascinating and most instructive topics; but on these our limits will not allow us to dwell. The uses of multitudes of the fishes to man, not only in indirect methods, through their mutual economy and through their common action upon water, but in the most direct methods by supplying him with food, with oil, with manure, and with some other valuable products, are great, and valuable, and very numerous, and might all seem to demand our special attention; yet as regards even these, we must content ourselves with merely a general remark or two on the use of fishes as food, and with a brief statement of their uses, whether whole or in garbage, as manure.

Fresh-water fish of not a few species are everywhere regarded as delicious food, and sought after with avidity; and, in many districts, they constantly form an article of luxury to some classes, and of commercial profit to others. In the mountainous parts of Scotland, which abound with large natural lakes and with rich trouting streams, fresh-water fish exist in great profusion, and can almost everywhere be obtained with little trouble or at small expense; but in less favoured districts, they are more scarce and high-priced; and in some, they are obtainable in sufficient quantity for even luxurious purposes, only by means of artificial ponds and careful conservation. Among the ancient Romans, fish-ponds were maintained at enormous cost, and belonged only to the most princely and luxurious families. Among the modern French, Germans, and Belgians, they are very common, and are carefully and skilfully managed; and in some parts of England, they are objects of particular care, and either afford large supplies to the private tables of landowners, or send profitable contributions to the public market. But in many other parts of England, and throughout most of Scotland, they are totally neglected, and in some instances despised; and yet in not a few of these, they might readily be made objects either of enjoyment to the wealthy or of profit to the industrious. Some countries, such as Sweden, which are both cold and mountainous, pay much attention to the artificial rearing of fresh-water fish; and why should not Scotland? "In England, too," says the Rev. W. B. Daniel, "many acres of swampy, moorish grounds, producing little food for cattle, and, in their present state, a trifling rent, might be profitably converted into fish-ponds, particularly within 30 or 40 miles of the metropolis. An acre of water, after being two years stocked, will annually yield 200 carp and 100 tench, that will sell upon the spot to the London fishmongers at a shilling each,—an income to be obtained from no other produce to which such sort of land can be appropriated."

Carp and tench are very vivacious, and much more easily transported alive than char or trout; and they might be profusely and with large profit propagated and maintained in even small and shallow ponds; and yet, they continue, up till near the middle of the 19th century, to be wholly unknown in the market of Edinburgh! While these two species rank among the most tender and delicious of the edible fresh-water fishes, they are at the same time hardy,—they scarcely ever fail,—they agree well as joint-occupants of one pond,—and, when stocked in the proportion of one male to three or four females, they multiply with great rapidity; and, in many a moorish and swampy-spot of Scotland, so situated as to be easily made the basin of a permanent pond, they might constantly be produced in great numbers either for the private table or for the public market. Some excellent pond-fish, particularly the common char, the burn-trout, the bull-trout, the salmon-trout, the hirling or whitling trout, and the Lochleven speckled grey trout, are indigenous in the waters of Scotland, and may easily, in almost any situation, whether in moor or park, be maintained in multitudes ever ready for use. All that is wanted for them is a hollow piece of damp ground, with a feeder leading into it, free from any noxious mineral impregnation, —an embankment, and a sluice. The perch and the pike are also native fishes worthy of attention; yet when allowed access to a fish pond, they must not be allowed to become large or to multiply greatly, else they will destroy the weaker and more delicious species. But perch, pike, and eels ought rather to be kept in separate pieces of waste water; and the promiscuous stocking of them with carp, tench, and trout in a large pond, ought, in most instances, to be avoided. England boasts among her indigenous fresh-water fish the tench, the dace, the gudgeon, the rud, and the barbel; and Scotland, though she has none of these, boasts the bream, the chub, the roach, and, above all, the unique and very beautiful gwiniad of Lochlomond and vendise of the Castle-Loch of Lochmaben. Scotland, too, though miserably poor in fish-ponds of fresh-water fish, is exceedingly rich in most kinds of edible marine fishes which frequent large arms of the sea, and possesses several salt-water fish-ponds, stocked principally with turbot, cod, haddock, whiting, thorn-back, coal-fish, and salmon.

The quantity of sea-fish caught on the coasts of Great Britain and Ireland, and used as food for man, is so great as to excite the astonishment of most superficial thinkers; and yet is far less than almost any one acquainted with the resources of the fisheries, and especially with the number, wealth, and vast aggregate extent of the fishing-banks, would readily anticipate. The herring fishery is fitful and subject to great and remarkable mutations; but most of the other species of fisheries are sufficiently steady to afford fair scope for employment without either pecuniary risk or mental enterprise. A division of attention between fishing and farming extensively prevails upon the coasts of Ireland, and on some parts of the coasts of Scotland, and is, more or less in all seasons, exceedingly injurious to both occupations; but whenever fishing is vigorously prosecuted as a distinct avocation, in well-appointed boats, by groups of families or entire village communities who have been trained to it from their youth, it rarely fails, not merely to afford a good and constant livelihood to the parties engaged in it, but to furnish large supplies of food to the general population. The number of persons at present employed, directly and indirectly, in the fisheries of Great Britain and Ireland is probably not less than a quarter of a million, the amount of capital sunk in these fisheries, is astonishingly great; and the protections and aids afforded them by legal enactment and incorporated societies have been many, important, and various. In 1832, the number of fishing-boats employed in the herring and cod fisheries was 11,059, the number of fishermen 49,164, and the number of coopers, curers, and other auxiliaries 31,402; and in 1837, the number of fishing-boats employed in the same two fisheries was 11,494, the number of fishermen 51,907, and the number of coopers, curers, and other auxiliaries 34,626. In 1832, in connexion with the British fisheries, 362,660 barrels of herrings were cured, 157,839 barrels were branded, and 217,499 barrels were exported; and in 1837, 397,737 barrels were cured, 114,192 barrels were branded, and 189,265 barrels were exported. Among the principal sea fish currently supplied in a fresh state to British markets are herring, cod, ling, salmon, turbot, mackerel, haddock, whiting, coal-fish, and soles; and in favourable seasons, so many mackerel alone as about 100,000 per week are supplied to Billingsgate market in London.

Fish, in whatever state applied to land, are a very powerful manure. Their skin consists principally of gelatine; their softer parts, whether immediately below the skin or among the viscera, comprise a large proportion of oil or fatty matter; their scales consist principally of coagulated albumen; their muscular or fleshy parts abound in both oleaginous matter and nitrogenous elements; their bones consist principally of phosphate of lime and carbonate of lime; and even their "guts" or refuse, while in a fresh or undecomposing state, contain about 4 per cent. of nitrogen, or are ten times richer in that all-important element than ordinary farm-yard manure. Fish of all kinds, therefore, in all conditions, and in all their parts, are powerful fertilizers.

Pilchards, either in a fresh state or in a salted state, but especially in the state of refuse, are extensively employed as manure in Cornwall and Devonshire. They abound in oily matter, and exert a very high fertilizing power. They are usually mixed with sand, soil, or sea-weed, in order to prevent them from raising too luxuriant a crop, and they generally maintain their fertilizing action during a series of years. Yet both pilchards and other kinds of fish probably give off the greater portion of their nitrogenous principles with comparatively great rapidity, and prolong their manurial action principally by the progressive evolution of hydrogen and carbon in the course of the slow decomposition of their oily matter.

Sprats and the spawn and young brood of other kinds of fish are employed in enormous quantities as manure in the sea-board districts of Kent, Essex and Suffolk. A very extensive fishery exists for the sole purpose of obtaining these for the farmer; and has been long and bitterly complained of as a destructive nuisance to the fisheries for higher purposes. "The nets used in it," says a Parliamentary Report of 1833, "are of a very fine description, so small as not to let a pen pass through, and they enclose not only sprats, but the spawn and young brood of all other kinds of fish; and as these nets are frequently drawn along the ground, and in shallow waters, during the breeding season, and in the winter months before the young fish are gone into deep waters, an immense destruction of the spawn and brood of fish is the inevitable consequence; whilst, from the almost unlimited demand for this species of manure for land, and there being a ready sale for all that can be procured, this branch of fishing has greatly increased, and there are at present from 400 to 500 boats engaged in Stow-boating on the Kentish-coast only, which remain upon the fishing grounds frequently for a week together, not for the purpose of catching sprats or any other fish to be sold as food in the market, but until they have obtained full cargoes of dead fish for the purpose of manuring the land." This manure is very generally used upon the immediate coast of Kent, Essex, and Suffolk; and is also carried in large quantities to districts 10 or 15 miles inland. It is applied in proportions varying from 25 to 45 bushels per acre; and it acts with highly fertilizing power upon gravelly soils and other kinds of poor lands, but usually expends all or most of its force in a single season. One common method of applying it is to spread it by hand, in a fresh and unmixed state, on winter fallow in preparation for oats; and another is to mix it with soil, to allow it partially to decompose, and to cart it to spring fallow, in immediate preparation for turnips.

The small fish called sticklebacks are caught in large quantities in the shallow waters on the margins of the fens of Cambridgeshire, Norfolk, and Lincolnshire, and used as manure on the adjacent lands. They multiply with great rapidity; and, though small in size and limited in scope, they afford the few farmers a somewhat large supply. They are applied in the same methods, and nearly in the same proportion, as the sprats and spawn; and, like these also, they give out most or all of their power in a single season.

The refuse of such haddock, cod, ling, salmon, and other ordinary fish as are sold in a fresh state, usually constitutes one of the thousand miscellaneous ingredients of police manure; but the refuse of such of these fish as are caught at a great distance from large towns, and salted in large quantities for preservation, is always a distinct and bulky article of manure, and might easily be made a subject both of increasing profit to the fishers, and of increasing interest and value to farmers. "The offal is preserved in rude pits, and sold to the neighbouring farmers; but as it undergoes very rapid decomposition, it is becoming customary to mix it with earth or peat. Great waste, however, generally takes place from the ignorance of the fishermen. The pits are always situated in front of the cottages, often dug in gravel or porous soil, and unprotected from rain and surface water; hence, whenever it rains, a great deal of the most valuable of the contents is carried off. Wherever it is found impossible to effect the removal of these pits to more appropriate places, and to exclude rain and surface water, tanks might be formed at little expense for receiving the drainings, and in which they might be neutralized, and mixed with any absorbent matters. It is probable, that in the vicinity of establishments for the manufacture of artificial manures, the fishermen will soon learn that the offal, so valuable, might be sold in a recent state at greater prices than they have hitherto obtained for it." [Davy's Agricultural Chemistry by Shier.]

The refuse of such herrings as are salted, is gathered and sold, not by the fishermen but by the curers, and is far less exposed to waste than the refuse of the ordinary fisheries. One kind of it is obtained during the process of curing, and consists of the brine, together with all the salt, blood, oil, and other matters which run off with it; and this is separately noticed in the article Brine. But the chief kind consists principally of the guts and other offals separated before the process of salting, and partly of a small proportion of the milt and the roe. This manure is held in high esteem by almost all farmers who can obtain it; and it is generally used in a fresh state, mixed up into a compost, and applied either largely in preparation for green crops or sparingly in preparation for white crops. In most parts of the east coast of Scotland, it sells at about 2s. per barrel; and, even when the ordinary expenses of carrying and composting it are added, it costs on the average somewhat less than two-thirds of the value of good farm-yard manure. The number of barrels of herrings cured in Great Britain in 1841 was 489,620; and the quantity of offal from these must have amounted to upwards of 6,300 tons,—a quantity equal to 63,000 tons of good farm-yard manure, and capable of abundantly manuring at least 3,000 acres for an entire rotation of green and white crops. An incidental consideration of considerable importance, too, is that this great supply of valuable manure occurs to a great extent in the neighbourhood of some of the most agricultural districts of Scotland. But a caution requires to be borne in mind by all who use herring-refuse, or indeed any similar kind of fish-manure, that an excessive application of it to light land is liable to overstimulate the soil for a few seasons, at the expense of afterwards entailing upon it a degree of feebleness amounting almost to sterility.—Herrings themselves, in a season of exuberant plenty, have occasionally been fished ashore in enormous quantities, and laid upon the land as manure. But this practice, whether viewed in the light of economy or in that of morality, seems of exceedingly questionable propriety.—*Davy's Agricultural Chemistry by Shier.—Johnson on Fertilizers.—Transactions of the Highland Society.—Daniel's Rural Sports.—Anderson's Commercial Dictionary.—Knight's Museum of Animated Nature.—Hunter's Georgical Essays.—Mill's Husbandry.—Mortimer's Husbandry.—Conversations Lexicon.*

FISH-POISON,—botanically *Lepidium Piscidium.* A hardy, annual, economical plant, of the pepperwort genus. It was introduced to Britain from the Society Islands in the latter part of last century. It has usually a height of about a foot, and flowers in autumn; and it possesses a close affinity to common garden cress, only that its silicles are somewhat elliptical, while those of garden cress are somewhat orbicular.

FISH-POND. See Fish.

FISTULA. A deep callous ulcer in man or in any of the domestic animals. The word fistula properly signifies a pipe or a reed; the epithet fistulous is applicable to any object which has the slenderly cylindrical form of a reed; and the particular kind of ulcers called fistulæ or fistulous sores receive this designation from their supposed similarity in shape to parts of reeds. Most of these ulcers are hard, long, and sinuous; and many communicate with somewhat large interior cavities, and have small external orifices.

Fistulæ are caused by severe and prolonged pressure, by bruises, by blows, by the continued presence or interference of foreign bodies, and by any other excitants of great and constant local inflammation. They occur most frequently on the withers of horses, from the effect of injurious pressure of the saddle; and they are also not infrequent in the poll and the sternum of the horse, and in the shoulders of working oxen; and in the last of these cases, they arise from the injurious pressure of the yoke exactly in the same manner as those in the withers of horses arise from the injurious pressure of the saddle. Simple abscesses or ulcers generally precede fistulæ, and might in every instance be very easily cured; and even fistulæ themselves, in their early stages, might, in most instances, be rapidly reduced by means of gentle discutients; but fully formed fistulæ are, for the most part, decidedly difficult to be cured, and, in some instances, cannot be reduced except by very severe treatment.

When any part of a horse's body subject to fistula becomes seriously excoriated or somewhat ulcerated, or shows heat, tenderness, and swelling, it ought instantly to be plied with fomentations, lotions, and cooling ointments. If the sore, instead of healing, should become an abscess, it ought to be punctured with a lancet, and emptied of as much as possible of its purulent matter; and a pledget of tow soaked with digestive ointment should be placed in the cavity, and afterwards removed, in order to absorb the fresh secretions of pus. But when a fistula is actually formed—when the ulcer or tumour has degenerated into a deep and callous condition, and contains any hard sinus or sinuses of a strictly fistulous character—some perforating, cutting, or very caustic operation becomes indispensable. "The sinuses or pipes," says White, "are to be laid open with a knife; and if it is practicable, a depending opening is to be made, that the matter may run off freely; the sore is then to be dressed with an ointment, which is to be melted and poured into the cavity while very hot." Some farriers, of the red-hot school, who for ever brandish the red-hot cautery, recommend the application of murderously scalding mixtures; and others think themselves very gentle in recommending a surface sponging with a mixture of one part of aqua-fortis and two parts of water. But both the shortest and the least painful method of cure, in all cases which are not superlatively obstinate, "is to pass a seton from the bottom of the sinus towards the shoulders, so as to insure a drain or dependent outlet for the matter." An instance is recorded by Professor Dick of a surpassingly bad case of fistula in the withers having been cured by Mr. Steel of Biggar principally by making dependent orifices, cleaning the wound, and dressing it with stimulating washes and digestive ointment.

FISTULA. A tropical, evergreen, medicinal tree. See the article Cassia.

FISTULOUS PLANTS. Plants whose stems, leaves, or flowers have the tubular form of pipes or reeds.

FITS. See Epilepsy.

FIXED OILS. There are two species of oil in vegetables, agreeing in the common properties of unctuosity and inflammability, but essentially different in many of their chemical qualities. The one, being capable of being volatized without decomposition, is named *volatile oil;* the other is denominated *fixed oil.* The latter is generally contained in the seeds and fruits of vegetables, and varies in its properties, according to the plants by which it is afforded. The fixed oils are extracted by pressure, and, accordingly, are frequently called *expressed oils.* When the process is aided by heat, the action of which is to render the oil more fluid, the product is esteemed less pure. The purest oils are those expressed from the fruit of the olive, or the seeds of the almond; others, less pure, come from flaxseed and hemp-seed. These oils are usually fluid, but of a somewhat thick consistence, and liable to congeal at very moderate colds; palm oil is even, naturally, concrete. When fluid, they are transparent, of a yellow or yellowish green colour, and capable of being rendered quite transparent by the use of animal charcoal. They are inodorous and insipid, at least if they have been obtained with due care; and free from the mucilaginous and extractive matter of the plants from whence they come; are lighter than water, with which they do not unite, and are very sparingly soluble in alcohol, with the exception of castor-oil. At a temperature below 600° Fahr., they remain unchanged. In the neighbourhood of this temperature, however, they begin to boil, and to disengage an inflammable vapour; but the oil thus condensed is altered in its properties; it loses its mildness, becomes more limpid and volatile, a portion of carbon being likewise deposited. Transmitted through an ignited tube, fixed oil is converted into carbonic acid and carbureted hydrogen, with a small portion of acid liquor, and a residuum of charcoal. In the open air, it burns with a clear white light, and formation of water and carbonic acid gas. Accordingly, the fixed oils are capable of being employed for the purposes of artificial illumination, as well in lamps as for the manufacture of gas. Fixed oils undergo considerable change by exposure to the air. The rancidity which then takes place is occasioned by the mucilaginous matters which they contain becoming acid. From the operation of the same cause, they gradually lose their limpidity, and some of them, which are hence called *drying oils*, become so dry, that they no longer feel unctuous to the touch, nor give a stain to paper. This property, for which linseed oil is remarkable, may be communicated quickly, by heating the oil in an open vessel. The drying oils are employed for making oil-paint, and, mixed with lamp-black, constitute printers' ink. During the process of drying, oxygen is absorbed in considerable quantity. This absorption of oxygen is, under certain circumstances, so abundant and rapid, and accompanied with such a free disengagement of caloric, that light, porous, combustible materials, such as lamp-black, hemp or cotton-seed may be kindled by it. Many instances of spontaneous combustion have occurred from this cause. The same thing happens with mixtures of oil and fine charcoal, and with lamp-black wrapped up in linen; from whence it is conjectured, that many extensive fires, which have broken out in cotton manufactories, and for which no cause could be assigned, must have arisen from this spontaneous inflammability of oils. Fixed oils unite with the common metallic oxides. Of these compounds, the most interesting is that with the oxide of lead. When linseed oil is heated with a small quantity of litharge, a liquid results which is powerfully drying, and is employed as oil varnish. Olive-oil, combined with half its weight of litharge, forms the common *diachylon plaster*. The fixed oils are readily attacked by alkalies. With ammonia, they form a soapy liquid, to which the name of *volatile liniment* is applied. They are oxidated by a number of the acids. Sulphuric acid soon renders them black; the oxygen of the acid attracting part of the hydrogen of the oil, and causing the deposition of charcoal; and if heat is applied, a large portion of sulphurous acid is disengaged, and even sulphur is evolved. Nitric acid renders them thick; if heat is applied, the action is more rapid, and a yellow colour is communicated, the oil being rendered concrete. Chlorine thickens oil, and renders it white. When boiled in sulphur, a compound is formed of a brown colour, a very fetid smell and acrid taste. It likewise, when heated, dissolves phosphorus, forming a liquid which becomes luminous, when exposed to the air. Olive-oil, according to the analysis of Gay-Lussac and Thénard, consists of carbon 77.213, oxygen 9.427, and hydrogen 13.360.

FIXTURES. All such parts of premises, whether erected by himself or not, as a tenant cannot lawfully remove or take down at the expiration of his tenancy. The law respecting them is ill-defined, and admits of far more liberal interpretation in the case of manufacturers than in the case of farmers; and in order to prevent disputes, special agreement respecting fixtures of any importance should be made with the landlord and recorded in the covenant or lease. Yet a general principle seems to be explicitly enough embodied in the law, that all erections directly founded in the land are legally fixtures, and that erections resting on some mediate substance are not fixtures; so that a brewery still set in brick-work founded in the soil is a fixture, and a barn on a frame resting on the surface of the ground is not a fixture. The technical name for the demolition or the unlawful removal of any structure or part of a structure of the legal nature of a fixture, is waste; and Williams, speaking on the subject of waste in his Farmers' Lawyer, says, "If the house was uncovered at the commencement of the lease, it is no waste if the tenant suffers it to fall into further decay, without pulling it down; or if the walls were uncovered or insufficiently supported, or if the house was ruinous, and the tenant suffers it to be as it was, without permitting it to become more ruinous. So also it is no waste if the tenant removes furnaces, coppers, or other utensils of trade, though fixed to the freehold, if he removes them before the expiration of his term; but if he permits them to remain after the expiration of the term, he cannot remove them, for they are then vested in the reversioner or landlord. In like manner, green and hot-houses are removable; so a barn erected on the premises upon blocks of timber; and this notwithstanding there be a covenant to leave all buildings which then were or should be erected on the premises in repair; for such covenant means, that the tenant shall leave all buildings annexed to and become part of the reversionary estate: but if the tenant will actually build, he must leave the buildings for the benefit of the landlord; thus if the tenant erect a beast-house, a carpenter's shop, a cart-house, pump-house, or fold-yard wall, letting such buildings into the ground, he cannot remove the same; for there is a distinction between erections necessary to the purposes of trade or manufactures, such as hot-houses, and the like, and those that are requisite in order to the better enjoyment of the land demised, such as beast-houses and the like; and therefore those of the latter description are not removable by the out-going tenant, but must remain for the benefit of the inheritance." A conservatory on a foundation of brick-work or masonry, and attached to a dwelling-house, is a fixture; an oven is a fixture; and an edging of boxwood, shrubs, and fruit-trees, though planted by the tenant, are fixtures; but a pump erected by a tenant, in such a manner as to be removable without damage to the adjoining property, is not a fixture.

FLACOURTIA. A genus of tropical evergreen shrubs and trees, forming the type of the natural order Flacourtianeæ. This order comprises only three genera, and was formerly included in the order Tiliaceæ. Its seeds are attached, upon a branched placenta, to the inner lining of its fruit; but its other characters are more or less identical with those of the lime trees. Eight species of the genus Flacourtia, all white-flowered, and varying in height from 4 to 24 feet, have been introduced to Britain from India and Southern Africa; and four of these are more or less valued in their native country for their edible fruit; while one in particular, *F. Ramontchi*, is a well-known small fruit-tree of Madagascar.

FLAG. Any rigid, sword-leaved, herbaceous aquatic plant,—particularly the wild iris, the calamus aromaticus, and the flat-shaped species of Aroideæ, Fluviales, and Cyperaceæ; also, the furrow-slice of lea-lands; also, the turf or surface-slice of lands subjected to the process of paring and burning; also, any large flat paving-stone, particularly a stone of hard and thickly laminated greywacke or sandstone.

FLAIL. A hand implement for threshing corn. It is both simple and ancient; it is the only threshing implement in use over a large portion of Continental Europe; and though now very generally superseded in Britain by threshing machines, it continues to be in use for general purposes on multitudes of small farms, and for particular purposes, such as the threshing out of garden crops, of small seed crops, and of specimens or samples of the grain crops, on even large farms. It consists of a hand-staff, or light ashen rod, of about 5 feet in length; a beater or rod of ash, thorn, or other wood, of from 30 to 36 inches in length and 1¼ or 1½ inch in diameter; and such a mutual attachment of the hand-staff and the beater, as will allow the latter free play both in striking the corn and in gyrating round the head of the thresher. The method of using the flail is so well and universally known as not to require description.

FLAMMULA. See Clematis.

FLANK. The part of a quadruped's body which extends from the ribs to the haunches. When the flank of a horse is abnormally large, it is accompanied by weakness in the loins and too great length in the back; and when it is hollow, it indicates comparative shortness in the transverse processes of the lumbar vertebræ, and consequent insufficiency of space for the due attachment of the large muscles of the loins. Either fever or a diseased state of the lungs is indicated by a comparatively rapid rising and falling of the flank in respiration.

FLAP OF THE EAR. The pendulous part of the ear of a dog. A great tumefaction sometimes takes place in the flap, particularly of spaniels, hounds, pointers, setters, and poodles; and whenever the tumour is either stubborn or of enormous size, it ought either to be opened up from end to end with a lancet or pierced through with a seton.

FLAT-PEA,—botanically *Platylobium*. A genus of ornamental, Australian, evergreen shrubs, of the lotus division of the leguminous order. Four species, all orange-flowered and about 4 feet high, have been introduced to the greenhouses of Britain.

FLAUGHTER-SPADE. See Breast-Plough.

FLAVERIA. A genus of herbaceous plants, of the sunflower division of the composite order. *F. Contrayerba*, called by Cavanilles *Milleria Contrayerba*, is a biennial rooted native of Chili and Peru, and was introduced to Britain toward the close of last century; and it is a medicinal plant, and is used in its native country as a yellow dye.

FLAX,—botanically *Linum*. A genus of plants, of the carnation family. Four species are indigenous in Great Britain; upwards of forty species have been introduced from foreign countries; and about twenty additional species have been scientifically described. Seven or eight of the introduced exotic species are evergreen undershrubs; seven or eight are hardy annuals or biennials; and most of the others are hardy perennial-rooted herbs. All the calyxes of the genus have five entire sepals; all the corollæ have five inferiorly-placed petals; and all the capsules have ten cells.

The Principal Species of Flax.—The common or most-used species, *Linum usitatissimum*, is a reputed native of the corn-fields of Britain, but either was introduced from Egypt, or has arisen out of the cultivation of some of the wilder species. Its root is simple, fibrous, and annual; its stems are smooth, slender, erect, and generally solitary, and divide into numerous branches near the top, and usually attain a height of from 18 to 24 inches; its leaves are alternate, narrow, lanceolate, and somewhat glaucous; its flowers grow in a corymbose panicle, have a pale purplish blue colour, and bloom in June and July; its capsules are globular and about the size of pease; and its seeds are flat, oval, glossy, outwardly brown, and inwardly white, with highly mucilaginous skin, and powerfully oily cotyledons.

The white-flowered variety of this species, *L. u. flore-albo*, possesses the same habit as the normal plant, but has white-coloured flowers, and generally a whiter and finer fibre.—The oval-headed variety, *L. u. capsula ovata*, is comparatively short and rigid in its stem, and has oval-shaped and somewhat pointed capsules.—The tallest variety, *L. u. altissimum*, is distinguished by the comparative length and slenderness of its stems.—Other varieties are somewhat numerous; and some are popularly characterized by certain distinguishable peculiarities in their habit, and others by the countries whence they are obtained, as the Riga flax, the Dutch flax, and the Russian flax. However much these varieties differ from one another in distinctive features, and in the amount and quality of their produce, they all, when grown for a few years in the same circumstances and with the same culture, become so completely assimilated to one another as very strikingly to evince their specific identity; and yet they are originally so very different in their height, bulk, strength, and earliness, and especially in the quality of their fibre and the amount of their seeds, that they require to be well noted from one another, and kept perfectly distinct. One variety is low in stature, rapid in growth, coarse in fibre, and prolific in seed, and is often well adapted to the producing of mere seeds; another variety is very tall, fine, and slender, and suits well for the production of excellent fibre under the most favourable circumstances of culture; and other varieties possess intermediate characters and adaptations, fitting them for different soils and situations, and for the diversified or mixed purposes of the flax husbandry.

One grand use of the common flax, in its several varieties, is the production of fibre for the manufacture of all the multitudes of kinds of linen fabric; and another grand use is the production of seeds, partly for food to cattle, partly for the expression of linseed oil, and partly for purposes of medicine. So exceedingly important is the production of flax-fibre, linseed-cake, and linseed-oil, that the discussion of it in identity with the cultivation of the flax plant must occupy most of the sequel of the present long article; and as to the medicinal uses of the seeds, they serve, in numerous cases and in several methods of preparation, as excellent emollients and demulcents. "The mucus obtained by infusion," says Dr. A. T. Thomson, "is a cheap and very useful demulcent in catarrh, pneumonia, diarrhœa, and dysentery, visceral inflammations, calculus, gonorrhœa, ardor urinæ, and during the exhibition of oxymuriate of mercury. When the seeds are boiled in water, the mucus is obtained in union with a portion of the oil, forming an useful local remedy when given in the form of enema in abrasions of the intestines and tenesmus, particularly in the advanced stage of puerperal fever. The seeds, ground into powder or meal, and simply mixed with boiling water, form an excellent poultice." The uses of the seeds, both whole and ground, both in internal exhibition and in external application, are valuable also in cattle medicine. See the article Linseed.

The English or perennial flax, *Linum anglicum* or *Linum perenne*, grows wild on chalky soils in the south of England. Its root is perennial; its stems are numerous, branching, spreading, and usually from 24 to 30 inches high; its leaves are alternate and lanceolate; its sepals are smooth, obovate, and obtuse; its flowers are large and blue, and bloom in June and July; and its fibre is strong and somewhat coarse, and cannot without difficulty be separated from the woody matter of the stems. This species can be profitably cultivated on poor light chalky soils, of the kind on which it grows wild; but though often recommended and often put to the trial on other soils and in other situations, it cannot be cultivated on any of these with sufficient success. It nowhere yields an available crop till the second year after sowing; but, in favourable circumstances, it afterwards lasts and produces through a considerable series of years. Though far inferior to the common flax, it seems superior to all the other species yet tried for the profitable produce of fibre.

The purging flax, *Linum catharticum*, is a native of dry and hilly pastures in various parts of Britain. Its root is annual and small; its stems are erect, smooth, leafy and delicate, simple below, divided above, and from 3 to 9 inches high; its leaves are opposite, lanceolate, obtuse, and entire; its flowers are small and white, nodding in the bud, and erect in the bloom, and they usually appear from June till August; and its seeds are yellow and shining. This plant, whether in a green or in a dried state, has little smell and a bitter taste. It is boiled by some of the peasantry in ale or beer for the cure of rheumatism; and it figures both in medico-botanical works and in the London and Dublin pharmacopœias as a useful purgative; but it possesses no peculiarly advantageous properties, and ought to be dismissed from the materia medica as a usurper of the place of better drugs.

The narrow-leaved flax, *Linum angustifolium*, grows wild in sandy pastures in various parts of Britain. It has a perennial root and a height of about 12 or 15 inches, carries purple-coloured flowers, and usually blooms in July.—The large-flowered flax, *Linum grandiflorum*, is a perennial-rooted native of the south of Europe, and was introduced to Britain in 1820. It carries handsome blue flowers, and blooms in June and July. —The strict flax, *Linum strictum*, is a biennial-rooted native of the south of Europe, and was introduced to Britain about the middle of last century. It carries yellow flowers, is usually about a foot high, and blooms from May till July. —The Narbonne flax, *Linum narbonense*, is a herbaceous evergreen of the south of France, and was introduced to Britain about the same time as the strict flax. It is usually from 2 to 2½ feet high; and it carries blue flowers, and blooms from May till July.—The hairy flax, *Linum hirsutum*, is a perennial-rooted native of Austria, and was introduced to Britain about the same time as the two preceding species. It is usually from 18 to 24 inches high; and it carries blue flowers, and blooms in July and August.—The alpine flax, *Linum alpinum*, is a perennial-rooted native of Austria, and was introduced to Britain in 1739. It is usually from 4 to 8 inches high; and it bears blue flowers in July and August.—The suffruticose flax, *Linum suffruticosum*, is a small evergreen undershrub of Spain, and was introduced to Britain about the middle of last century. It has a height of from 10 to 15 inches, and it carries pink flowers, and blooms in August. —The species now enumerated are probably the nearest to the common and the English species in the value of their fibre; and all, as well as the great majority of the remaining species, have an ornamental appearance, and are more or less worthy of a place in the flower-garden. The annual and biennial ornamental species, and also some of the perennial-rooted kinds, should be sown in the open border; the dwarf species look well either on rock-work or in pots; the hardy undershrubby species do well in any kind of light soil; and the frame and greenhouse kinds succeed best in a mixture of loam and peat.

History of British Flax-Culture.—Flax has been cultivated in England and Scotland from time immemorial; and yet has never, in these countries, acquired the character of a regular, systematic, and prominent article of culture. In some districts and in fitful circumstances, it has secured a considerable amount of attention; but in Great Britain as a whole, and even at times of meagre or interrupted supply from Continental Europe, it has nowhere been treated as a steady and regular crop for the sake of its fibre. "A sufficient quantity," remarks the General Report of Scotland in 1814, "has not been hitherto cultivated to supply the wants of the country. Even in the present time, when the difficulty of procuring foreign supplies is so great, and when consequently imported flax has risen far beyond its former medium price, its culture in Scotland has not increased, notwithstanding all the advantages that are offered for its cultivation by premiums of considerable value, both in the quantity of flax, and the production of its seed. Yet a great extent of the soil of Scotland is well adapted for raising this crop to full perfection; and the circumstance of this article not being grown in quantity sufficient to supply a half of the demand, must either be owing to the price not being adequate to the expense, or the difficulties in the way of its cultivation serving as a discouragement to the husbandman." The chief hinderances, however, and such as became increasingly felt, and went far for a number of years to drive the very name of flax out of the nomenclature of British husbandry, were the supposed precariousness of the crop, the supposed exhausting effect of it upon the soil, the withdrawal of the bounties formerly offered for its cultivation, the prevailingly bad methods of preparing the fibre for the manufacturer, the excessive inroad which the preparation of the fibre made upon the ordinary avocations of the farm, the facility of obtaining good and cheap prepared flax from the Continent, and the enormous and increasing substitution of linen fabrics by fabrics of cotton. But within the last few years, attention has been aroused in England to the home-production of flax-seed, with the view of superseding the large and increasing importation of oil-cake for the feeding of cattle. Mr. John Warnes, an enterprizing Norfolk gentleman, originated the new movement; and, upon instituting comparative experiments, he obtained from the seed alone much more remunerating returns than had usually been realized in Great Britain and Ireland from the fibre; and he has satisfactorily shown, that without calculating anything whatever for the value of the fibre, the flax-plant can be so cultivated as successfully to compete with the present routine field crops of the British farmer. Other experimentalists, too, have brought out corroborative results; and in particular, several gentlemen of Norfolk, Suffolk, and Essex obtained flax seeds at the rate of from 20 to 29 bushels per acre, and Mr. Negus of Crimplesham near Downham in Norfolk obtained them at the rate of 32 bushels per acre; so that a very clear and encouraging prospect exists of flax-culture—if not in the elaborate form of producing fibre for fine linen fabrics, at least in the very facile and simple form of producing seeds for cattle-food—becoming a regular and important department of the agricultural industry of Britain.

The cultivation of flax was introduced to Ireland from the Low Countries before the close of the 17th century; and it for a long period largely engaged the attention of the farmers throughout most of Ulster and part of Leinster. It was aided and stimulated, for upwards of a century, by the most liberal parliamentary grants, and by bounties on exportation; and it was far better suited to the economy of the small-farm, hand-hoeing, and limitedly-rotational system of Ireland than to the large-farm, horse-hoeing, and fallow-cropping system of Great Britain. The circumstances in which the fibre was used, too, were such as to protect the Irish cultivators from the injurious effects of competition with the better-skilled and the more industrious cultivators of Belgium and Holland; so that, though the preparation of the fibre for the manufacturer was exceedingly faulty, and greatly damaged the general quality of the article, the work of cultivation continued to be carried on with vigour. But after the year 1824, when the parliamentary grants and bounties were withdrawn, the cultivation rapidly diminished in both spirit and amount, till, after the lapse of a few years, it seemed dwindling away to extinction; and though plant, soil, climate, and social circumstances were all favourable, the method of preparing the fibre was so bad as almost to forbid all hope of such improvement as might successfully compete with continental growers. In 1841, however, the Belfast Flax Improvement Society was formed to give a new impulse to the cultivation; and it speedily originated numerous active auxiliaries, and spread far and wide masses of arousing information, which introduced a totally new system of flax-culture, and invested it with brilliant prospects of great and permanent success. "In Ireland until recently," said Mr. Nicholls in 1845, "the cultivation of flax was much neglected, and the flax raised was of a very inferior quality. This was not so much owing to the inferior nature of the plant, as to the mode of managing it after it was drawn; and the Society which was established a few years ago directed its earliest attention to correct this defective management. They brought over skilful cultivators from Belgium to instruct the people; and afterwards, finding that this was not sufficient for the purpose, they selected a number of intelligent young men, and sent them to Belgium to learn the Flemish mode of cultivating and preparing the flax; and the result has been, that not only has the quantity of flax grown greatly increased since the Society commenced its operations, but the quality of the flax has likewise greatly improved; and Ireland may now look forward, at no very distant day, to produce as much as she requires of this the great staple of her manufactures." The results of the Belfast Flax Improvement Society, in fact, have been successful beyond the most sanguine expectations of its founders and supporters; and they comprise not only the revival and great improvement of flax-culture in Ireland itself, but the introduction of it, under the most promising circumstances, to some districts of Great Britain.

Eligibility of Flax-Culture.—An opinion was for a long time almost universal in Britain, and is still very general, that the flax crop is always precarious in this country, and but seldom remunerating. Even so late as 1842, one of the best Irish writers on agriculture said, "Flax is a hazardous crop; and, on this account, its cultivation cannot be regarded as on the increase. In the market price there is also great variation, being sometimes very high, while in others it is so low that it cannot be regarded as remunerating." Yet this writer wisely adds, by way of qualifying his remark, that if the saving of the seed were properly attended to, so as to combine the profits of the seed with those of the fibre, "the culture of flax would be better deserving of encouragement than it is at present, as it would then be greatly more remunerating to the cultivator."

In fact, the saving of the seed and the improved method of preparing the fibre—two great additions which have, within the last few years, been made to the current practical notions of cultivating flax in Britain and Ireland—have entirely changed the economical aspect of the crop, and now afford ample promise, that what was formerly precarious and losing, may henceforth be, to the full, as certain and compensatory as any of the oldest and best established routine crops of our fields. "Until lately," said a writer in the Irish Farmer's Journal in 1845, "the object of the cultivation of flax was solely for the fibre, the seed being entirely disregarded, partly from the circumstance of its value not being properly understood, and partly also from an erroneous opinion being entertained, that the saving of the seed would be injurious to the fibre. Under these circumstances, it will be perceived, that the full value of the crop was not taken advantage of; and from the returns obtained by such a course of management, no just estimate of the flax plant could be formed. This will be more apparent when it is considered, that in circumstances unfavourable to the production of fibre, an extra quantity of seed will be obtained, and *vice versa.* When advantage is taken of both products, it will therefore be seen that a failure can rarely occur, although when one only is regarded, such a casualty may occasionally take place. That increased attention is now paid to the seed in the north of Ireland, we learn from a recent report of the Belfast Society, in which it is stated, that almost everywhere through the country, this season, a large portion has been saved, and the quality of the fibre has not been at all thereby deteriorated, as has been erroneously supposed. From fully one-sixth of the present crop, the seed has been saved, and either used for feeding or sold for the oil mills, the total value of which cannot be estimated at less than from £60,000 to £80,000. It is further believed, that in a few years all the seed of the Irish flax crop will be saved, and an addition thus made to the resources of the country amounting nearly to half-a-million sterling per annum."

How much the improved method of preparing the fibre may affect the value of the crop, cannot be very closely ascertained, and must necessarily be variable according to the degree both of former deficiency and of present improvement; but it cannot be less than considerable, and possibly is quite enough, even without the mighty aid of saving the seed, to convert a constantly precarious crop into a decidedly and generally safe one. The quantity of flax imported into the United

Kingdom from Belgium, Holland, Germany, and the ports of the Baltic has long been so enormous as to demonstrate the existence of a sufficient home demand for even the largest produce which British farmers may for a long time be likely to raise; and the occasional production of fine fibre in the days of barbarous British culture, and especially the general production of fine fibre under the improved methods which have recently begun to be adopted, abundantly prove that the soil, climate, and cultorial appliances of the United Kingdom are quite as favourable for the production of prime flax as the palmiest districts of Continental Europe. "In 1841," remarks the writer in the Irish Farmer's Journal already quoted, "the importations of flax alone amounted to about 80,000 tons, at an expense of from £5,000,000 to £6,000,000; and if the sum paid for seed and oil-cake be taken into account, the annual outlay cannot have been less than from 10 to 12 millions sterling. That the superiority of the foreign flax was attributed solely to the superior management it was made to undergo, was abundantly evident from the fact, that occasionally samples were produced at home which could successfully compete with any imported. It was clear, therefore, that if the practice adopted in the cases in which the fine samples were produced was generally acted on, the enormous annual outlay above referred to would be saved, and the growth and management of the crop rendered almost as profitable to the cultivator as it was in its palmiest days." Improved preparation of the fibre, then, is likely to work out more profit than accrued from the whole of the former system of grants and bounties; and it is incomparably more honourable to the feelings of the cultivator, vastly better fitted to induce a healthy and vigorous exercise of his intellect, and far more adapted to secure both steadiness and permanence of beneficial results.

The conditions of soil most suitable for the flax-plant, the peculiar secretions effected by the plant itself in the several parts of its organic structure, and the mutual adaptations to which it readily accommodates itself with other plants in agricultural rotations, are all highly favourable to its constant cultivation on British farms. A soil of moderate richness is the utmost which the flax-plant requires; a light, sandy, and decidedly poor soil is sometimes perfectly sufficient; and even a common and but ill-reclaimed bog soil has been known to produce remunerating crops. Far less manure is required than for some other agricultural plants of kindred value; for when manure is either rich or abundant, the whole plant is too strong and luxuriant, and the fibre is coarse and of inferior quality. All the fibrous portion of the plant is elaborated out of the elements of air and water; so that the fibre alone might year after year for ages be removed from the soil, or the plant might for ages be cultivated on the same field by always returning to it the seeds, the scutchings, and the steep-water, without occasioning a single particle of impoverishment. Even the seeds contain a very small portion of inorganic matter, or matter derived from the soil, compared to the whole bulk; and when they are all used in cattle-feeding on the farm, and their inorganic principles afterwards returned to the land as an item of farm-yard manure, they too as well as the fibre may be taken off for ages without causing impoverishment,—while the other items of farm-yard manure, returned along with their inorganic principles, necessarily act in the way of enrichment. Fewer agricultural delusions have been more absurd than the fancy that flax is an exhausting crop; or, in any instances in which this has been less a downright delusion than a seeming fact, all the exhaustion entailed upon flax land has accrued from the waste of the steep-water and especially of the seed and the scutchings. Recent experiments, too, have abundantly proved that the flax-crop can easily interchange its manurial refuse with other crops, and that, as a member of rotations on farms of either the mixed or the alternate husbandry, it acts excellently before either turnips, barley, or clover. "The general introduction of flax-culture into England," remarks Mr. Nicholls in the Royal Agricultural Society's Journal of 1845, "would constitute a new and most valuable element in the rotation, and would enable the farmer to vary and extend his successions, which is in itself a highly important consideration. The water in which flax has been steeped is highly fertilizing when applied to the land; and the seed, when properly saved and prepared, constitutes excellent provender for cattle and milch cows. It may be safely asserted, therefore, that a flax-crop rightly managed is not only valuable as affording increased means of employment for an agricultural population, and highly profitable for the purposes of the manufacturer, and for the feeding of cattle, but that it moreover returns to the soil, in the shape of manure, as much if not more than any of the grain crops."

Soils for Flax.—The soil most suitable for flax is of medium quality between stiff and loose, between clay and sand, between wet and dry,—any soil, in fact, which does not readily part with moisture, and yet is quite free from stagnant water. A strong clay or a retentive subsoil is too wet for flax in rainy weather, and too hard and compact for it in dry weather; and a dry sandy or gravelly soil, upon an irretentive subsoil, is far too dry for it, and allows it to languish and become dwarfed and feeble for want of a requisite degree of moisture. Some of medium quality, suitable for wheat crops, is excellent for flax; cold clayey soil on a clayey bottom, if thoroughly drained and well pulverized, does exceedingly well; light sand or light peat upon a retentive subsoil or in a very humid climate, is not amiss; soil of any kind abounding in humus and of middle-rate cohesiveness, is prime; and light lea land, which has been laid down clean and in good order, and which has borne a crop of oats after being broken up, is highly suitable. Friable wheat-bearing soil was formerly viewed as unable to endure the scourge of both wheat and flax; but may now, since the discovery of the non-exhausting nature of the latter, be regarded as exceedingly eligible for flax; and the very best land of this description in Belgium and the north of France, constituting a deep rich loam and locally known under the name of fat land, is very frequently and most successfully subjected in succession to wheat and flax. A clayey loam is preferred by some of the Belgians for flax; and a sandy loam by others. Every variety of soil which Holland contains is used for flax; and the greater portion of this is marine alluvium, mixed with a black mould somewhat similar in appearance to peat. Some very rich land situated to the north of Rotterdam and called droog-maakery or "land made dry," bears excellent crops of flax in dry seasons, but allows them almost to perish in very rainy seasons. "The strongest clay that I saw in Holland," says Mr. Aiton, "was a few miles north from Breda, and the flax on it did not appear to advantage, owing in part to the land being full of weeds and slovenly farmed. Between Dort and Rotterdam, and in some other districts, where the soil is chiefly sand, mixed with black mud or sediment, but situated so low as not readily to become too dry, the flax I saw growing was excellent, and that of last year's crop, which I saw in various stages of manufacture, was also of the very best quality; but in very rainy seasons the flax on such land is apt to lodge." The alluvial land of the Scottish haughs or of the richest of the English meadows, does well for flax when loamy, but causes it to be lodged when clayey. An upper-stratum of black mossy earth, provincially known as "grey land," combined with an under-stratum of clay, and resting on a subsoil of till or argillaceous gravel, has in some parts of Scotland produced crops of flax of comparatively far higher value than its best possible crops of oats. "Moorland of a clayey bottom, and having much mossy earth on its surface, and which would not yield more than five bolls of oats per acre, has often yielded, when the season was favourable, from 20 to 40 stones of flax per acre."—Flax, in the climate of England or Ireland, will succeed in proper soil at the height of 700 feet above the level of the sea; but it ought not, in even the lowest and most favourable situations, to be sown in small enclosures, or near the shade of plantations or of high hedges; for it requires full light and ample ventilation in order to escape the attack of mildew.

Preparation for the Flax Crop.—The manuring of land for flax ought, in many instances, to have reference far more to the mechanical than to the chemical condition of the soil. Land, for the most part, is in far more danger of being too rich for flax than too poor for it; and, whatever be its condition, as to either its own mineral constitution or the recent cropping it has undergone, is best prepared for flax by being very moderately affected with stimulating manure, very thoroughly cleaned of weeds, and either mechanically or by means of mineral intermixture rendered finely yet very slowly porous to the permeation of water. Treatment suitable for one set of lands, whether by manuring, fallowing, or tillage, would be very unsuitable for another set; and exceedingly different treatments, sometimes ignorantly and sometimes with great skill, have been both practised and recommended.

If land be in a fit enough condition for bearing oats, it ought not to be manurially fertilized for flax; if it contain an over-proportion of clay, it may receive a dose of lime or other calcareous manure; if it be light and hungry, it ought to contain the residue of a very powerful dose of stimulating manure, applied to the preceding crop; if it be of medium texture and somewhat exhausted in fertility, it may be strengthened by a dose of peat ashes, of burnt ditch scourings, or of tolerably good police manure; and if it be a poor lea-land, broken up for oats to precede the flax, it ought to enjoy the effects of a manuring upon the sward. But the general practice in Belgium, where flax is frequently preceded by wheat or even both preceded and followed by it, and where the nitrogenous and alkaline principles previously in the soil have been in a main degree dissipated, is to make a very liberal application of finely-divided stimulating manure; and a distinguished British writer on agriculture—more in allusion to this fact than to what is proper in the usual circumstances of our own country,—says, "The most effective manure for flax is the sweepings of the streets in towns, mixed with the emptying of privies and the cleaning out of the butchers' stalls and shambles. On light soils, much manure is required; and where night-soil cannot be obtained in sufficient quantities, rape-cakes from which the oil has been expressed, dissolved in cows' urine, form the best manure. In many parts of Flanders, 500 rape-cakes are used for every acre of flax, besides the usual quantity of Dutch ashes and of liquid manure, which is the drainings of dunghills and the urine of cattle collected in a cistern and allowed to become putrid." But the most powerful and even common liquid manure of the Flemish farmers consists of the urine of cattle and the drainings of water-closets, almost saturated or at least mightily impregnated with rape-cakes; and this is very generally or even chiefly applied to the flax-crop. "The field, after two or three harrowings, is backed up in the centre, and ploughed round in but one set, so as to leave it without any furrow. A heavy roller is then drawn across the ploughing by three horses, the manure is spread equally over the entire surface; and, when well harrowed in by 8 or 9 strokes of the harrow, the seed is sown, which is also harrowed in by a light harrow with wooden pins of less than 3 inches; and the surface, to conclude the operation, is again carefully rolled, so that nothing can exceed the smoothness and cultivated appearance of fields thus accurately prepared."

When the land intended for flax is a heavy loam in tillage and foul with weeds, it requires to be as thoroughly worked and cleaned by the process of the summer-fallow as if it were intended for wheat; and it ought also to be trench-ploughed, to be worked deep, and to receive its dose of compost, of police manure, of somewhat short farm-yard manure, or of other suitable fertilizing manure at so very early a period of the fallow as to be completely incorporated with the soil previous to the sowing of the seed. When the land is a heavy loam but tolerably clean, it may bear a crop of potatoes instead of undergoing the summer part of the fallow; and in this case, it ought to receive as much extra manure as the potato-crop is likely to extract. When the land is under any other circumstances, no matter what be its precise character, or what crop it last bore, it ought to be broken up about the dead of winter, and thoroughly exposed to the mellowing action of the weather, and brought, if practicable, into as finely a pulverized condition as if all were to be disposed in the small seed-beds of a kitchen garden. The small farmers of the north of Ireland generally sow flax after potatoes, and prepare the land merely by furrowing with the spade and shovel, or sometimes with the plough, and by harrowing down in the spring without any ploughing; and they thus keep on the surface, to serve as the seed-bed, the precise stratum which has been exposed throughout the winter, and which contains the richest residue of manurial matter from the potato crop. But they certainly err at once in taking flax after potatoes, in giving the ground so little tilth, and in keeping the most fertilized portions of the soil at the surface. The Belgians generally take flax immediately after corn, or the second year after potatoes, or immediately after clover which has been one year in lea; and esteem it bad practice to take it immediately after either potatoes or turnips; and they usually give strong land three or even four preparatory ploughings, and plough light sandy land in January and February six inches deep, and thoroughly harrow it and heavily roll or trample it at the time of sowing.

"A winter and spring ploughing," says Mr. Aiton, "may be given in Belgium, where the climate is so fine that the farmers can sow their crops either early or late, as they find it to be convenient; but in Scotland, these operations would throw the sowing of the flax too late, and a second furrow would open the soil so much that the drought would hurt the lint. The most common preparation for flax in Scotland, and indeed the best that has yet been discovered, is to sow oats as a lea crop, and flax as the second crop. If the land is very rich, two crops may be taken,—say beans as the first, oats for the second, and flax for a third crop; or if the ground is not in danger of becoming foul, oats for the first crop, beans for the second, and oats for the third, to be followed with flax; and if the land is very poor, it may be manured on the sward, so as to secure a good crop of oats, and give a fair chance of good flax the crop after oats. In all cases, and in every species of soil, land intended for flax ought to be ploughed about the end of January or early in the month of February, that it may more readily retain a due proportion of moisture, so necessary for the growth of flax. If ploughed too early, the soil is injured by the winter rains, and soured into mortar, if a clay soil,—and the weeds will more readily gain a footing than when the ground is not ploughed so early; and when the ground is too late in being ploughed, or when it gets a second furrow in the spring, it is too much opened to the drought, and cannot retain through the summer that portion of moisture that a flax-crop requires." But these instructions must be greatly modified by the constitution of the soil and subsoil, the state of the subsoil drainage, the nature of the climate, and the direction and gradient of the exposure; and far surer instructions, though necessarily more indefinite ones, are so to treat the land as to combine a maximum of cleaning and pulverization with a medium degree of permeability to water. "The only other preparation for the seed," continues Mr. Aiton, "is to harrow the land well with ordinary iron-harrows, so as to bring to the surface any couch-weeds that can be come at, and which, with stones and every incumbrance, ought to be removed. Grass-harrows, or those having short teeth, if they are at hand, may be used in covering in the seed after it is sown; but ordinary harrows ought to be used in smoothing the ground for the seed, and they may do to cover it also, if no other are kept on the farm. If the soil is open and dry, it should be rolled; but not if the land is firm, and a heavy soil, or when the ground is damp at the time."

The Sowing of Flax.—The time of sowing flax in Britain and Ireland varies from about the third week of March till about the second week of May; and, though it must in every case be determined far more by the weather than by the calendar, yet it ought never if possible to be earlier than the last week of March, or later than about the 15th of April.—The seed is always sown broadcast, and either very lightly harrowed in or both harrowed and rolled according to the condition of the soil; but it requires, in every instance, to lie very near the surface and to enjoy abundance of aeration,—for if deposited half an inch deep, it will not germinate. In Britain and Ireland, the covering of the seed is usually effected by a double turn of the harrows,—very commonly, by the ordinary harrows of the farm; but in Belgium, where the nature of the plant is better understood, and its habits have been closely observed, the covering is frequently effected on light soils in the same manner of treading in as the covering of fine seeds on the small beds of kitchen gardens, and generally on both these soils and all others by the light draught of a bush-harrow, or a hurdle, or a traineau.

The quantity of seed, or the thickness of sowing, ought to be far greater for a crop of fibre than for a crop of seeds. A thick growth of flax makes the stems run up to a comparatively great height, and prevents them from deflecting and ramifying, and consequently produces long, continuous, and fine fibres; while a thin growth dwarfs the height, enlarges the diameter, encourages many ramifications, and causes numerous deflections in the fibrous deposit, and consequently produces a short and coarse fibre, which makes a profusion of breaks in dressing, and runs much into the refuse or inferior sorts of dressed flax. The Belgians, especially in the prime flax districts, always grow their flax exceedingly thick, and appear either to use a somewhat larger proportion of seed than has been commonly used in Britain and Ireland, or to obtain a more uniform germination of it by means of their more cautious and scientific method of sowing. But when a crop of seed, and not fine fibre, is the cultivator's object, flax ought to be sown thin, in order that the plants may enjoy ample space and encouragement for branching during the time of growth, and may be stimulated and fed by the most abundant supplies of fresh air during the time of blooming and filling; for not only do the lateral shoots and the branches as well as the main stems of a thin crop bear seeds, but all the seeds, as compared to those of a thick crop, are superior in plumpness, weight, oil, and general value. About 3½ bushels per acre may be regarded as the proper quantity, in ordinary circumstances, for the finest fibre; 3 bushels, for ordinary fibre; and 2 or 2½ bushels for seed; yet these quantities must be modified both by the particular variety of the seed used, and by the peculiar conditions of the land.

Clover and grass forage plants might seem, at first sight, to form a very suitable joint crop with flax, or at least to be as much in keeping with flax as with corn; but, with flax, and especially with flax grown thick for the sake of the fibre, they want sufficient space and aeration, and are liable to be dwarfed, enfeebled or utterly smothered. Yet the sowing of grass-seeds with flax-seeds is thought by many persons a good practice; and, whenever this practice is adopted, the grass-seeds should be sown, not simultaneously with the flax-seeds, but by a separate broad-casting, either on the same day to be harrowed in along with the flax-seeds, or at the time of the weeding of the young flax-plants to be covered in by the creeping movement of the weeders. If all the various seeds were mixed together with the view of being simultaneously sown, the flax-seeds and the clover-seeds, on account of their comparative smallness and weight, would sink to the bottom, the hand of the sower would often be filled far more with one kind of seeds than with another, and the action of even the slightest breeze upon each handful would occasion the flax-seeds and the clover-seeds to fall much more to leeward than the grass-seeds.

The Weeding of Flax.—Every young flax crop ought to be thoroughly hand-weeded when the crops are about three inches high. If the weeding take place before the plants are three inches high, a large proportion of the weeds will not be sufficiently up to be detected and eradicated; and if it do not take place till the plants are four or five inches high, the crop may be so seriously bruised and broken by the weeders as not readily to rise again, and as to retain a permanent feebleness or tendency to fracture in the fibre at the parts where the plants were bent. Women and children ought to conduct the weeding process, in the same kneeling or lying posture and with the same creeping movement as in the cleaning of the seed-beds of kitchen-gardens; and in Belgium, they weed on their hands and knees, in order that they may have a close view of even the smallest weeds,—tie coarse pieces of cloth round their knees, in order to bruise the plants as little as possible,—and creep forward with their face to the wind, in order that such plants as are lodged may be assisted by the breeze to rise. But the hand-weeding of all sorts of broadcast crops on the Continent is conducted in such a way as to suggest improvement to British farmers. "All sorts of crops," remarks Mr. Aiton, "are carefully hand-weeded in Holland, Belgium, and France; and this is the greatest superiority that the farmers in these countries display over their brethren in Britain. From the month of April till the end of June, you may see groups of people, of both sexes and of every age able to pull weeds, lying or standing on one species of crop or another, either hand-weeding or hoeing with the greatest care; and when the wheat or other crops are anywhere too thick, they pull up part of the stems along with the weeds, and every plant they pull is carried home to the farm-house, and boiled with chaff, cut straw, &c., and served up to the cows in the form of soup." All couch and other weeds with stoloniferous roots or creeping stems ought to have been extirpated in the preparatory processes of tillage; but if any remain, they must not be torn up during the hand-weeding, for they would tear up more flax-plants by their removal than they will damage by remaining. Natural grasses, too, may be let alone; for either they are of a nature to do very trifling injury, or of a habit of root to do more harm by eradication than by growing.

The Pulling of Flax.—Flax is gathered by being pulled up carefully and in small handfuls by the root. It ought, in every case, to be pulled when perfectly dry; for if it be in even a slight degree damp, it sustains much damage from the rubbing and bruising action of the hand in pulling. Any portion of the crop which may have become lodged before being ready for gathering, ought to be immediately pulled and placed by itself, for it cannot have strength to undergo the operation of scutching along with the sound portions of the crop; and every part which becomes ready for gathering before the rest, whether occurring in patches in the best divisions of the field or in belts along the crown of the ridges, ought to be pulled without waiting for even one day till the less forward parts become ready. The whole process of pulling, whether rapid or very prolonged, ought with all possible care and judgment to be so conducted as to effect a thorough assortment of all the different qualities on the field, so that all the damaged portions of the crop may form one group, all the coarse portions another, all the medium portions another, and all the finest portions another. The careful assorting of the different qualities of a crop as they are pulled, is one great secret of the success of flax-culture in the Low Countries as to both the excellence of the fibre and the superior quality of the seeds; and were it duly practised in Great Britain and Ireland, it would greatly increase the aggregate market value of our flax produce, and powerfully subserve the desirable object of deriving a joint profit from at once oil-seeds, food-seeds, coarse fibre, and fine fibre.

When the chief object of flax is thoroughly ripened seed, whether for next year's sowing or for the expression of oil, it should grow till the capsules acquire a brown colour, and become firm and hard, with their points so sharp as to fix themselves in the skin of the hand that presses them, and till nearly all the leaves have fallen from the stems or have become yellow and begun to wither; when the chief object is to combine the saving of the seed for consumption as cattle-food with the obtaining of a fibre sufficiently good for the common or more ordinary purposes of the linen manufacture, the flax should grow till the seeds are quite fully formed, but not till they are ripened; and when the chief object is a maximum quantity of the finest attainable quality of fibre, the crop should grow only till the flowers begin to fall off, or till only the lower leaves and the lower part of the stem begin to turn yellowish, or till about three weeks before the natural time of the seeds becoming ripe. When flax for the manufacturer is pulled too soon, the fibre is weak and soft; and when it passes into a state of ripeness suitable to the yielding of mature seed, the fibre is dry, hard, course, and ill-coloured.

Flax pulled with a special view to the seed is laid in handfuls crossing each other as they are pulled, and is allowed to remain for a few days in this state to wither and to mature the seed; and flax intended jointly for the seed and the fibre, and designed to be early rippled and steeped, is often treated in the same way. Almost all flax, upon the old Irish and British method of treatment, was hurried direct from the field to the steeping-pond without any reference whatever to the saving of the seed; but in the improved methods, most of it, whatever be its precise or special destination, is bound by the pullers into loose sheaves or bunches, and arranged long enough into hoodless stooks to have its seeds sufficiently hardened for the process of rippling, and its whole substance if requisite sufficiently winnowed to be stored up for some months either in well-covered stacks or in barns. The bands for tieing the sheaves may be formed either of the flax itself, or of single lengths of wheaten straw, or, what is much better, of bruised and dried rushes; and the pullers may carry supplies of them round their waists, and take them down one by one as they are wanted. The stooking of the flax, or the arranging of it into small drying-stacks, is the furthest preparatory labour requisite when the rippling and the steeping are performed in autumn; but the building of it into large stacks or the storing of it into barns, though a very operose work, becomes indispensable when the rippling and the steeping are postponed till spring. The stacks common in some flax countries are as wide as the bundles are long, about 8 or 9 feet high, and frequently from 20 to 30 feet long. "If the field is extensive, several of these stacks are formed at regular distances; they are carefully thatched at top; and the ends, which are quite perpendicular, are kept up by means of two strong poles driven perpendicularly into the ground; these stacks look from a distance like short mud walls, such as are seen in Devonshire."

"The management of the crop after pulling," says the Irish Farmer's Journal, "will depend on whether it is to be watered in the autumn or in the ensuing spring. The former practice has been almost universal in Ireland, but the latter is very generally employed on the Continent. Where the crop is to be watered in the autumn, the Dutch growers lay the flax in handfuls, after pulling, until a small heap is thus formed, each handful crossing the preceding one, so that the flax is easily afterwards taken up in rippling. The handfuls must not be made too large, or they will be grasped and retained with difficulty during that process. After remaining a short time in this manner, the seed-pods are taken off by the rippling-comb. Before rippling, the pods should have become so much hardened that they will break readily when pressed between the finger and thumb. Another mode of treating the flax and saving the seed, is to allow the latter to remain on the stock until the following spring; and this is obviously the method by which seed of the best quality is obtained. This kind of management has been carried to very great perfection on the Continent; and so famous has the district around Courtray, in the north of France, become for it, that it is usually known as the Courtray system. The superior quality of the flax produced in those districts shows that the plan is equally adapted for the production of the finest fibre as well as the best quality of seed. According to this system, the flax, after being pulled, is placed on end in the manner of sheaves in a stook; and so skilfully is it arranged in this position, that it is difficult to blow down by winds, nor has rain much effect upon it. It stands in this position for eight or ten days, by which time, if the weather be fine, it will be thoroughly dried, after which it is to be bound up in bunches, and made up into small wind-stooks in the field, after remaining in which for some time it is carried home to the barn, or stacked in some convenient situation during the winter. The seed may then be taken off during the winter or spring, as leisure permits; but in this case, it is not taken off by the ripple, but by a sort of thrashing, the foot of the workman, during the operation, being kept on the floor, to prevent its being displaced and entangled, which would cause it to be destroyed in the after-processes of manufacture. The treatment of the crop is the same, with little variation, when the fibre is the chief object; and the Courtray practice, where the best flax is produced, is to stack the crop and allow it to remain so throughout the winter, the watering then taking place in the spring or summer ensuing. Most of our farmers, it is true, can scarcely afford to remain so long without obtaining a return from their crop; but did not this difficulty arise, it is apparent that this system of management is attended by many advantages. According to the usual practice of watering in the autumn, the treatment of the crop often materially interferes with the operations of the harvest; and for the grassing of it very unfavourable weather frequently occurs; but these difficulties are entirely obviated by grassing in the beginning of the summer following. Throughout a considerable proportion of the flax-growing districts in the north of Ireland, an unfounded prejudice prevails against the adoption of this course of management, on the supposed ground of a coarse quality of fibre being thereby produced; but the experience of the Courtray farmers is decidedly opposed to this opinion, as they produce the finest samples which come into our market."

The Rippling of Flax.—The old method, practised in Great Britain and Ireland, of paying no attention to flax-seed, but allowing it to perish during the process of steeping, was one of the most outrageous instances of waste ever known in the practice of agriculture. The steeping of the seed along with the whole plant damaged the quality of the fibre, rendered the water poisonous to fishes, and sent up such effluvia into the atmosphere as made the whole vicinity both very disagreeable and decidedly unwholesome. The removal of the seed, even irrespective of its own value, facilitates the several operations to which the flax is subjected, and occasions both a considerable saving of the time of the workmen, and a very material improvement in the quality of the fibre. But the intrinsic value of the seed, especially when estimated in the light of the many useful purposes which the seed itself, its ground meal, its oil, and its oil-cakes can be made to serve, is, in the aggregate, very nearly equal to the value of the fibre; so that a neglect of the seed, additional to the consequent nuisance and mischief, amounts to the waste of almost one half of the whole crop. "The seed of flax is always taken off on the Continent, and preserved, either to be sown, or to be bruised for oil, or given to cattle; and it betrays great want of industry to do otherwise in any country. The seed of flax may not always answer to be sown in Britain, nor can the whole of it be wanted for seed; but it is too valuable for the oil it contains, and as food for cattle, to allow any part of it to be lost. It is of great value, both as food and as medicine, for cattle, and particularly for horses. From the extraordinary labour performed by cart and road horses, and the high feeding they require, they are often subjected to inflammation in their blood and intestines, by which much property is lost. But if the proprietors of horses could be induced to give each of them a single handful of linseed daily or occasionally, boiled with beans or other food, it would operate as an antidote or a cure to those inflammations by which so many horses are lost." See the article LINSEED.

The seed, when properly dried on the pulled plants, may be removed, either in a comparatively fresh state by rippling, or in a comparatively withered and indurated state by thrashing or beating. When the plants have been thoroughly and uniformly dried, they are less likely to suffer injury during the process of rippling or thrashing than if they were badly or irregularly dried; yet they must, in any case, be very gently rubbed or handled, else their fibre will be injured. The rippling implement is a sort of comb, with smooth, cylindrical, tapering, iron teeth, about 12 inches in length, and adjusted so close to one another as to let the stems but not the seeds pass between them; it may be so fastened on the middle of a long stool or short form as to let two persons sit on opposite sides of it, and make alternate passes of handfuls of flax through its teeth; and the stool ought to stand on a large sheet of canvass or large winnow cloth, so that the seeds may be caught as they fall, and prevented from being scattered or injured on the floor The separation of the seed by thrashing or beating, is effected by means of a flat wooden bat, somewhat similar to a small cricket-bat.

If the seed be rippled in even a slightly damp condition, it cannot without great difficulty be afterwards dried or prevented from heating. It ought, in this case, to be frequently turned on the floor of the barn or of some other well-ventilated apartment; and the turnings ought at first to be frequent, and afterwards continued as long and as often as the circumstances of the seed and air and temperature may require. When the capsules are thoroughly dried, they may be passed through a winnowing-machine, to drive off any dust which may be attached to them; and they may then be stored for use. But when the seed is not rippled till spring, it is in general very easily saved; and, for this reason, all seed intended for sowing or otherwise required to be perfectly sound, ought to be thoroughly dried in autumn, kept properly stacked through winter, and not rippled till the fine dry weather of spring. If the weather at the time of the pulling of the crop should be in any degree unsettled, the seed then rippled may be in all respects perfectly good for food, but cannot possibly be so well preserved as to be relied upon for sowing.

The Steeping of Flax.—The steeping of flax in water excites a fermentation in the juices of the plant, dissolves the mucilaginous cement between the woody stem and the fibrous interior, and destroys the network of minute vessels which exists interwovenly with the longitudinal fibres; and it, in consequence, facilitates the separation of the woody matter from the fibres in the subsequent process of scutching, and converts the natural mass of fibrous network into artificial fascicles of perfectly free and filiform fibres. But the process of steeping requires great nicety as to the water employed, the receptacles in which the water is held, the manner in which the flax is deposited in the water, and especially the length of time, or rather the amount of chemical change, which transpires between the beginning and the end of the process. Too small an amount of change will render the operation of scutching both difficult and injurious; too great an amount of change will partially decompose the fibre itself, or render much of it fit only for tow; even an hour or two of difference of time will sometimes sensibly affect the quality of the fibre; and the various circumstances of softness, stagnation, and cleanness in the water, and of such a method of depositing the flax in it as to secure an uniform degree of chemical action in every part of a stem, of a bundle, and of an entire deposit, may modify both the appearance and the useful properties of the fibre to probably one-third or even almost one-half of its marketable value. The profitable production of fibre, in fact, depends more upon the proper steeping of the flax than upon all the other processes of either culture or preparation.

The Dutch enjoy eminent advantages for steeping flax, yet do not always turn them to the best account. The numerous small canals or fosses which divide and subdivide their estates and farms, and which serve as fences to the different enclosures, are admirably adapted to the steeping of flax, and have probably been the main cause of the high reputation which Dutch flax has so long enjoyed. The fosses receive the rain-water from the surface of the adjacent fields; they are always open to the sun and weather; they are so shallow as easily to absorb and retain heat, and to be kept always warm; and they have just enough of current to be maintained in a state of purity without in any proper degree acquiring the character of streams. A Dutch flax-grower constructs a dam across one of the fosses, cleans out the weeds and the mud for a few yards adjacent to the dam, lays in three or four rows of sheaves of flax next the dam, packs the sheaves close together with the root end down and the top end slanting toward the dam, covers the three or four rows of sheaves with a stratum of about six inches of the rank herbage and the bottom-mud of the fosse, and proceeds to deposit more courses of sheaves and to give them the same covering of weeds and mud till the whole space is filled or the whole crop deposited. But the covering part of this process is very decidedly objectionable, and so pollutes and stains the fibre with the silt and the vile weeds as to damage its appearance, to deteriorate its quality, and to occasion great unnecessary trouble in the subsequent processes of cleaning. The prime adaptation of the fosses for steeping is, in a serious degree, counteracted by the dirty and unreflecting practice of covering the flax with mud.

The steeping of flax in the Courtray district is a distinct occupation or trade, and is conducted in a manner so highly beneficial to the quality of the fibre that crops are sent thither from all parts of Flanders to be steeped. "A piece of water over which alders grow is chosen in preference, as the leaves of that tree steeped in the water give the flax a peculiar tint, which is thought desirable; or if such a place is not at hand, alder leaves are sometimes tied up in the bundles of flax. It is thought that the alder leaves also drive away insects, which injure the fibres of the flax while steeping. The best and most experienced steepers, however, disregard these notions, and prefer the clear soft water of the river Lys, which they confine in long ponds made for the purpose along the side of the river, of such a depth that the flax may stand nearly upright in them without touching the bottom. This requires a depth of five feet or more. If they cannot be made so deep, the flax must be placed in a slanting position in the water, the root end lowermost, and the upper end a little under the surface of the water. It is kept in this position by means of mats spread over it; and poles with stones placed on them keep the mats down and the whole under water. Some steepers tie the bundles together in pairs, the root end of one to the seed end of the other, so that half the flax leans upwards in the water and half downwards; but there seems no good reason for this practice, for, as the root end is sooner steeped than the upper, it will be unequally steeped, even if the flax be laid horizontally in the water, which is not thought so good as placing it vertically or nearly

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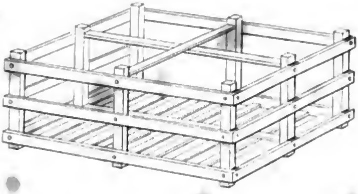

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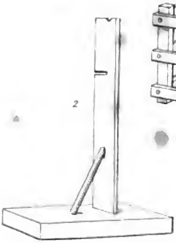

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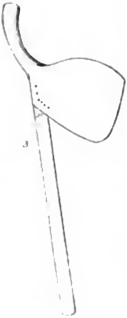

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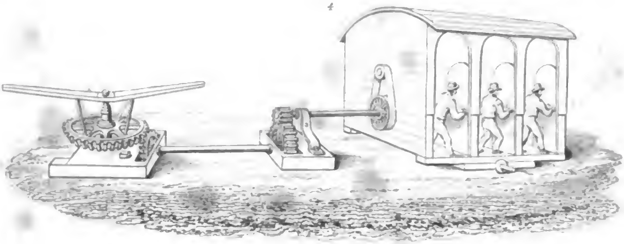

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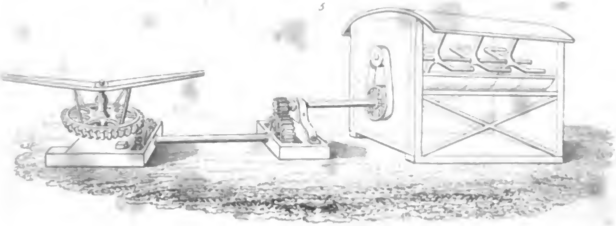


so. But as these men have great experience in the process, we must hesitate before we blame a practice of which we do not immediately see the advantage. Those who steep the flax in the Lys itself, collect it in thick bundles nearly a foot in diameter, and somewhat longer than the flax, by laying several small bundles together, as described above. In these large bundles, the roots project at each end, and the tops are inside. They are tied round very tight in two places, about six inches from each end. They are then placed upright and closely packed in a cage, or open frame, made of wood and laths, ten feet square, and four deep; boards loaded with stones are placed over the top, so as to sink the whole a few inches below the water of the river. Thus the water runs over and under the frame, and is continually changed. The consequence of this is, that the flax becomes of a clean white colour, without the usual bluish tint, and is therefore more valuable. The time of steeping is somewhat longer than in stagnant water. It is pretended by those who do not adopt this method, that there is a considerable loss in the weight of flax steeped in this way, which counterbalances the superior value. This is, however, not clearly proved; and the quantity of flax which is brought from a great distance to be thus steeped, is a presumptive proof that this method is, on the whole, the most profitable, and the best." The cage used for watering in the Lys is represented in *Fig.* 1. *Plate XX.*

Very few streams in Britain or Ireland present similar conditions for steeping as either the Lys or the Dutch fosses; and the great majority of British and Irish flax-growing districts must be dependent for good steeping upon pieces of water artificially collected. The pond or trench, if not excavated in clay, ought to be made retentive by puddling; it ought to be scoured clean of all impurities; it ought to be from 8 to 10 feet wide, and to have a sufficient depth of water to allow the tallest flax plants to be fairly covered, without their touching the bottom; it ought to have merely such an influx of water as will maintain purity and supply waste by evaporation and absorption, without producing any very perceptible current; and the water which fills it ought to be soft, limpid, and perfectly free from any mineral impregnation. The flax ought to be deposited in loose sheaves, and in either an erect or a slightly slanting position, with the tops uppermost; and slightly covered with wheat-straw, fern, rushes, or coarse clean herbage, and gently loaded with as many boards and stones as will keep the tops fairly and constantly beneath the water. The requisite time for the proper degree of steeping, varies with the qualities of the water, the nature of the situation, the comparative fineness of the flax, and especially the season of the year and the temperature of the earth and the atmosphere; and it has been found to range from 5 to 10 days in warm weather, and from 8 to 14 or 15 days in cold weather. In all ordinary circumstances, flax in the process of steeping ought to be carefully examined every day from the fifth or the sixth after deposition till it is found ready for removal; and when it undergoes rapid fermentation or change, it ought, toward the end, to be examined three, four, or even six times a-day. The disappearance of air bubbles from the surface of the water, and an apparent tendency of the flax to settle to the bottom, have been regarded as indications of the requisite degree of change being complete; but a far safer guide, and one which ought always to be resorted to, is to draw a few stems from different parts of the pond, and to ascertain by fracture and rubbing whether the woody matter is easily separable from the fibre; and whenever a doubt exists as to the proper degree of fermentation being complete, a good rule is rather to remove the flax a few hours before the full time, than to let it remain a single hour past it.

The Grassing of Flax.—When flax is removed from the steeping-pond it ought to be laid on the banks, with the ends of the sheaves a little elevated, in order that it may be freed from the bulk of the water with which it is saturated; and after it has lain there for an hour or two, it must be spread out on a surface of grass-land about as extensive as the area on which it grew, in order that it may complete its fermentation, and be cleansed by wind and rain from its impurities, and may be bleached by alternate shade and sunshine, and by alternate wetting and drying, into a whitish and fine-looking colour. Old pasture land, with a thick, short, fine sward is most suitable; and when artificial grass land or any land with long or rank herbage is used, it must, previously to the spreading, be either eaten close down by sheep or neatly and evenly shaven with the scythe. The flax should be spread, not thinly, but rather thickly, in order that it may neither be unduly hardened by the weather, nor injuriously tossed by the wind. It ought, also, for the sake of securing uniformity of colour, to be regularly and frequently turned. The flax-growers of the Continent secure goodness of tint in their flax by the niceties of grassing, and uniformity in that tint by careful and regular turnings; they run long poles or wattles under the successive rows, and turn them over in such a manner that each occupies the place vacated by the preceding one; and they go through the process with perfect ease and regularity, and make the surface of the whole crop as even and orderly after any number of turnings as when it was first spread. The turnings ought, in as many instances as possible, to be made on the near approach of rain; and they have always more effect, upon both the purifying and the bleaching, when the grassing is performed in spring than when it is performed in autumn. A main part of the dun and irregular colour which sometimes so materially depreciates British and Irish flax in the market, is attributable to slovenly grassing; and a weakness of the fibre, occasionally observable in the whitest and finest flax of the Continent, is attributable to the opposite fault of excessive operoseness and too great bleaching action in the grassing.

A facile and somewhat popular substitute for the grassing process has long been known in Scotland under the name of gaiting, and probably has had some share in depreciating the market value of British flax. The sheaves have their bands drawn up toward the top; and are set up one by one, with their root end on the ground, and well spread out, so that they may not be blown down by the wind, and may freely admit the air to play among their interior stems; and after they have stood two or not more than three days, they are turned inside out, thoroughly loosened to the air, bound gently up and set on their root end as before, and left to stand till they become completely dry. This method can always be practised upon a small spot of ground and in the immediate vicinity of the steeping-pond, and saves the expense of the grass-land, of carriage, and of the process of spreading and turning; but it suffers the enormous defects of neither cleaning the flax, nor bleaching it, nor regularly completing its fermentation, nor securing for it uniformity of colour.

The proper length of time for grassing varies with the condition of the flax, the season of the year, and the character of the weather. Flax not quite sufficiently steeped must be grassed for a longer time than flax perfectly steeped; any kind or condition of flax requires longer grassing in continuously dry weather than in alternations of wet and dry; and flax of all sorts is far more liable to be injuriously prolonged in the grassing amid the cold and moisture of autumn than amid the comparative warmth and dryness of spring. In every case, flax must be perfectly dry when removed from the grass, otherwise it would afterwards heat and be destroyed; and when taken up, it may either be gathered for a few days into small hand-ricks or carried at once to the barn or into well-covered stacks, according to the assured dryness of its condition.

A kiln-drying is frequently given to the flax immediately before the process of scutching; and this, in some instances, is conducted in kilns or drying-houses, of about 15 feet in length, constructed for the purpose. But all such artificial drying is exceedingly injurious to the quality of the fibre, and ought, in every instance, to be rendered quite unnecessary by perfect drying on the grass. Yet Mr. Aiton says respecting it, "This seems to me to be a very necessary preparation that is neglected in Scotland, to the injury of the flax, and loss to the owner. Moderate drying of the flax seems to have a similar effect with drying of grain before it is ground into meal; and this might easily be done in Scotland on the corn-kilns."

The Scutching of Flax. The woody part of the stem of flax is technically called boon or shove; and, after the steeping, the grassing, and the drying are completed, this is separated from the fibre by the processes of bruising and scutching. The bruising apparatus used in Holland, Belgium, and the north of France, is very simple, and is worked by the hand. Four thin boards, about 15 inches long and 3 inches broad, and about 3 inches distant from one another, rest fixedly with their edges up at about 2½ feet from the ground; and three other boards, in all respects similar, are so attached to an upper, corresponding, and hinged base as to be freely moveable up and down, with their edges falling exactly into the interstices between the other boards. The workman raises the upper or moveable half, lays a handful of flax across the edges of the lower half, forces down upon it the edges of the upper half, and repeats this simple operation, turning the flax over and over, till the whole of the boon is completely bruised. The scutching apparatus, or that for clearing away the broken parts or fragments of the boon, is also manual and equally simple. The scutcher sits on a block of timber, about 18 inches high, and has at his right hand a fixed upright board, about the height of the arm of a chair, with a horizontal slit about 1½ inch wide, *Fig.* 2. *Plate XX.;* he lifts a handful of the bruised flax, twists the top end, and throws the root end over the slit in the board; he then lifts a small, flat, thin, hatchet-like piece of timber, with a short handle, and about the size of a soup plate, *Fig.* 3. *Plate XX.*; and with this instrument, he strikes the flax close to the upright board, turning it over and over with his left hand, and continuing to strike with his right till the one end of the handful of flax is clean, and then shifting it and performing the same operation upon the other end till it also is clean. The only other appliances used are a leathern apron for keeping the person tidy, a comb for unravelling any fibres which happen to become matted, and a sort of blunt mincing-knife for breaking over the knee any portion of the boon which may not have been sufficiently crushed during the process of bruising. The scutcher constantly feels the flax with his hand, judges of the progress of the scutching operation, and so regulates his strokes as to clear away all fragments of the boon and at the same time not injure the fibre.

The bruising and scutching of flax by hand, in this simple manner of the Dutch and the Belgians, acts much more softly and gently upon the fibre, and occasions far less loss by the waste of some parts and the deterioration of others, than any of the known methods, especially the older ones, of performing the processes by machinery. No flax bruised and scutched by a mill on the Continent ever commands the highest price in the market, or is found fit for the manufacture of the finest kind of fabrics. "When the work is done by the hand," remarks a recent Irish writer, "the different parts and qualities can be subjected merely to as much of the action of the handle as is necessary to clear away the shove, without breaking unnecessarily the flax itself. This is one of the advantages which the small farmer has in growing this crop, that the manufacture can be carried on in a superior manner by his own family, to whom it affords profitable employment. This is, in short, one of the departments of industry in which, so far as our knowledge at present extends, manual labour can never be superseded by machinery, wherever it is available." But the cleaning of flax on any large scale by manual labour, is necessarily far more expensive than the cleaning of it by machinery, and is often all but impossible in consequence of the want of a sufficient number of workers, and is needlessly operose and costly for any of the purposes of either coarse or middle-rate manufacture. The employment of multitudes of women in Britain, might comport with the profit of flax-growers in producing a fibre suitable for the finer kinds of fabrics; but the use of machinery is demanded by many considerations of economy in producing fibre for all ordinary fabrics.

The method of bruising flax long practised in Scotland, was to beat the flax with a hand-mallet upon a smooth stone, and so to bend and rub the flax, in connexion with the beating of it, as completely to break the boon. But, at a subsequent period, beaters were moved by the wheels of scutching-mills; and soon after, indented rollers were formed of such a kind as rapidly and thoroughly to crush all the boon. One roller, 3 feet in diameter, moves in the centre, two other rollers, each 14 inches in diameter, move upon the large one; all the three are indented to the depth of at least 2½ inches; and when they are moved round, each of the concaves of one roller falls into the convex of the other. The flax is spread thin, with merely the top of it let in between the rollers; and it is carried round with them, and completely crushed in the course of one revolution of the large roller, and then thrown out in a state of readiness for the scutching. The machinery for scutching is complex, and of the nature of a mill. An upright shaft or spindle is driven by either a water-wheel or horse-gearing; four arms, provided with wipers on their ends, and each about 7 feet 10 inches in length, are fixed in the shaft; the arms are moved round horizontally, within a box or frame, at the rate of 200 times per minute; and the flax is held in at holes or slits in the upper side of the frame, receives blows or scutchings from the revolving arms or wipers at the rate of 800 in the minute, and is in consequence so severely beaten as to lose all the boon and at the same time no inconsiderable portion of the fibre. This rapid and very rough method of scutching certainly saves a great amount of labour and wages; yet it destroys so much good fibre as, in some instances, to be really as expensive as the Dutch and Belgian method of scutching by hand.

A new flax-mill, invented two or three years ago by John Warnes, Jun., of Norfolk, combines the extraordinary advantages of being portable, of exhibiting a construction which may be adapted to various other forms of small mills, and of performing its work in a better manner than the previous flax-mills. The breaker has three pairs of fluted rollers, placed upon a strong frame of wood; cogged wheels are fixed to the rollers, and are so attached by a rigger and strap to the axle of the scutching-machine, as to be moved by the same power; and the flax is passed in small handfuls through the flutes of the rollers, and has all its boon completely bruised by the play within each other of the convexities and the concavities. The beaters of the scutching-machine play round an iron axle, and revolve at the rate of 1,500 times in the minute, and strike the flax held over boards placed perpendicularly and attached to the frame-work; and the close shed within which they work resembles a small caravan, and contains three recesses, similar to sentry-boxes, which serve as standing places to three workmen. The machines are represented in *Fig.* 4. and *Fig.* 5. *Plate XX.* They can be propelled either by manual labour, by horse-draught, or by a water-wheel. In one of the earliest experimental trials of the machines, the first of their class ever known in England, two stones of flax were broken in less than two minutes, and scutched in seventeen.

The Prospective Effects of Flax-Culture on Ireland.—The proceedings of the Irish Flax Improvement Society, incidentally noticed in two preceding sections of this article, appear to have opened a new and highly promising era in the industrial history of Ireland. The Society, encouraged by the success of its commencing operations in Ulster and the north of Leinster, directed its attention southward and westward, and sent some of its instructors to almost every part where the landed proprietors evinced a desire to avail themselves of their services. The results were very satisfactory, as the soils of the new districts proved peculiarly suitable to the plant; and as an instance of the rapidity with which its culture was introduced, where there were active and energetic landlords to co-operate,—on one estate in Mayo, where in 1844 no flax was grown, in 1846, 110 tons were brought to market, of the value of upwards of £5,000. The society's report for 1846, shows that its operations then extended over twenty-six counties, twenty-one being beyond the limits of Ulster; and at the annual meeting in Belfast, in November, 1846, Mr. W. Sharman Crawford, M. P., in moving the adoption of that report, made the following remarks: "It might be desirable now to consider what the resources of the country would admit of, and to take a review of the production of flax which might be created from the lands of Ireland, properly managed, on a rotation system. In the report of the commissioners for the return of the population, they found, that the portion of the lands of Ireland, fit for the purposes of agriculture, exclusive of all other descriptions, amounted to 13,464,300 acres. Instead of one-eighth, which it had been shown was perfectly consistent with good farming, let them suppose that only one-sixteenth were appropriated to flax, they should have 841,518 acres; six cwt., or about one-third of a ton, was considered a fair average produce by the acre: that would give no less than 252,455 tons; and, at £45 per ton, the value would be £11,360,475. Then, with regard to the employment which the cultivation of the plant gave, and which was a most important consideration, it had been shown that, independently of spinning, an acre of fine flax gave employment, for a year, to 19 persons, in manufacturing it into pocket-handkerchiefs; and, if spinners were added, there would be an addition of 44 women, making altogether 63 persons. But some people might think that an exaggerated statement; therefore let it be supposed that one acre of flax would be equal to the employment and support of one family for the year; then the result would be, supposing only the one-sixteenth of the lands of Ireland to be in flax—there would be 841,518 families so supported; and, taking each family at the usual average of five, the number of individuals sustained would be 4,207,590—equal to about one-half of the whole population of Ireland. Let them consider in how small a degree the manufacture of flax had hitherto advanced; and then let them look at the means and capabilities of Ireland—the immense water-power which was wasted. But he hoped that there would be a change that would induce the men of Ireland to look to the water-power; for, if they did, the remunerative prices of flax would be greatly increased."

It will be observed, that the amount to be produced on the estimate of Mr. Crawford, would be more than is required for the present consumption of the British islands. But it has been ascertained that French and Belgian spinners would largely import Irish flax, if it were grown in sufficient quantity for them, since it is much superior to the Russian which they now consume for the fabrication of particular yarns. The quantity of flax-seed at present imported into Britain from foreign markets, and also the oil-cakes which are at present made from foreign seeds, and consumed by the cattle-feeders of Great Britain, could then be all had at home, for they would be fully furnished by the produce of the number of acres which the above estimate of flax would occupy.

Among the many causes of Ireland's miserable condition, the want of manufactures has often been numbered. This is, of course, speaking on the general question, and in comparison with the striking features of British manufacturing industry. The linen trade is the single bright point presented in this view of the matter, serving more forcibly to show the advantages of a steady productive employment. Sixty-two large factories, with 2,860 horse power, and 13,600 operatives, are continually employed in spinning yarn, while large quantities are also purchased from the English and Scotch spinners; 70,000,000 yards of linen, on an average, are annually exported; the trade employs a capital of upwards of five millions sterling; and the entire number of individuals, directly and indirectly supported by it in all its branches, cannot be estimated at less than 500,000, and is probably more. This manufacture has now attained such a degree of perfection, that, in neutral markets, the Irish linens command the almost exclusive sale, having struggled against the produce of the German and French looms until they have gained the upper-hand in almost all cases. Even in the finest fabrics, damask and cambric, the progress has been surprising, the consumption of the latter having increased 160 fold in 17 years. In 1829, for every 1,000 dozens of French cambric sold in the English market, 100 pieces of Irish were sold; in 1846, for every 1,000 pieces of French, there were 16,000 pieces of Irish sold. Seeing their inability to compete with the Irish producers in the open market, foreigners have imposed heavy duties on Irish linens and linen-yarns in their own countries; and by this short-sighted policy they are cramping the consumption, injuring the consumers, and endeavouring to force a manufacture in which they cannot advantageously engage.

Great as must be the changes which the general adoption of the principles of free trade would produce, none would tell more beneficially on Ireland than the unshackled admission everywhere of its linen manufactures, their superiority and cheapness ensuring them a monopoly in the majority of cases. Should continental governments be induced by the example of England to relax their duties, the Irish linen trade would increase immensely. And the move which has been made by Britain in the admission of foreign agricultural products into a free competition with our own will have this important result—that it will lead all farmers in both Britain and Ireland to inquire, for what kinds of culture their soil and their climate are best adapted. No premium existing on the production of any particular crop, this point at once becomes all-important. It has been ascertained, by analysis, that the quantity of nitrogen in grain produced in the southern and middle parts of Europe, and in the United States of America, is greater per cent. than in that grain under the most favourable circumstances in Ireland; and the humid atmosphere of Ireland, on the other hand, highly favours the growth of grasses and herbage, of roots, of flax, and of hemp. Countries with a spare population are most fitted for the production of grain, since it takes the least labour; and where a large labouring population exists, the culture of roots and of fibrous plants is the most profitable, as it affords them a productive employment. Natural circumstances, then, at once point out, that it would be more fitting for Ireland to turn her attention to the culture of the succulent and the textile kinds of plants in connexion with the rearing and fattening of cattle, and not to lay the stress on grain that at present is done by the small farmers.

When the government, and politicians of all parties,—in fact, all thinking men, are labouring to devise means to turn to good account the present awful crisis in the state of Ireland, by planting the seeds of her future peace and prosperity, deeply and securely, that they may spring out of the ruins of her former unhappy condition, the extension of the cultivation of flax, in connexion with the condition and prospects of her linen manufacture, deserves serious attention from those in power. In many ways the importance of the subject has been alluded to. Sir R. Kane, in his "Industrial Resources of Ireland," the "Times Commissioner," in his able letters, and the "Poor-law Commissioners," in their Reports, all speak to the benefit which Ulster has derived from this branch of industry, and to the important effects which its extension would produce. —*Reports of the Belfast Flax Improvement Society.—Kane's Industrial Resources of Ireland.—Parliamentary Gazetteer of Ireland.— Pooler's Manual.— Museum Rusticum.— Irish Farmer's Journal.— Quarterly Journal of Agriculture.— Transactions of the Highland Society.—Sir John Sinclair's General Report of Scotland.—Society of Gentlemen's Complete Farmer.— Journal of the Royal Agricultural Society of England.—Sproule's Agriculture.— Doyle's Husbandry.— Outlines of Flemish Husbandry.— Lawson's Agriculturist's Manual.—Loudon's Works.—Gardener's Gazette.—Rham's Dictionary of the Farm.—Farmer's Magazine.—Mill's Husbandry.*

FLAX-DODDER,—botanically *Cuscuta Epilinum.* A mischievous, parasitical, convolvulaceous plant, of similar form and habits to the European and the lesser dodders, but specially infesting the flax crop. See the article DODDER. It has occasionally worked considerable devastation in the western counties of both Great Britain and Ireland; and it is popularly known in Somersetshire as "the mulberry," and in Connaught as "the parasite plant." A small consignment of Odessa flax-seed, received at Westport in 1836, brought with it such an import of flax-dodder as quite choked some of the crops immediately raised from that seed itself, and left large and mischievous traces upon the flax-fields throughout the four succeeding years. An opinion is entertained by some good judges that flax-dodder never accompanies flax-seed from either Riga or America, and is almost certain to accompany the comparatively cheap and dirty seed from Odessa.

FLAX-LILY, or NEW ZEALAND FLAX,—botanically *Phormium.* A genus of plants of the asphodel family. Only one species is known; and this is called the tough, *Phormium tenax*, and was introduced to Britain from New Zealand in 1798. It is a herbaceous evergreen. Its leaves rise from the root-crown, overlap one another for a little above the base, diverge alternately to two sides, and are tapering, pointed, equidistant, and three or four feet long; its flowers grow on a strong branching stalk, and have a light greenish colour, but can seldom be produced in Britain; and its seed-vessel is oblong and triangular, and contains compressed seeds. A fibre afforded by the leaves has been occasionally imported from Polynesia under the name of New Zealand flax, and is very remarkable for the strength and durability of the cordage which it makes. The plant is hardy enough to grow, without any protection, in the open air in Britain; and could it only be cultivated under conditions of soil and treatment similar to those of its native country, it might possibly become one of our most valuable economical field plants. But the fibre yielded by it in some trials in the south of Ireland, proved decidedly inferior to that imported from Polynesia; and, in consequence, an opinion has, for the present, gone abroad that the plant cannot be cultivated in this country with profit. A coloured figure of it is given in *Plate XXXVIII.*

FLAX-SEED. See LINSEED.

FLAX-STAR,—botanically *Lysimachia Linum-Stellatum.* A hardy, ornamental, annual-rooted plant, of the loose-strife genus. It is called by some botanists *Asterolinon stellatum.* It is a native of Italy, and was introduced to Britain about the middle of the 17th century. It has a height of 6 or 8 inches, carries a greenish flower, and usually blooms in June.

FLAX (TOAD). See TOADFLAX.

FLEA, — scientifically *Pulex irritans.* A well-known, nimble, annoying, suctorial, parasitical insect, of the apterous order. Its habits and general appearance do not require description. Its sucker is complex, and thoroughly adapted to its blood-drinking nature. A sharp razor-like apparatus, with its blade working on a kind of handle, exists on each side of a slender bristle-like tongue; and the blades are the maxillæ, while their sheaths are the mandibles. Turpentine is one of the best means of chasing away fleas, whether from place or animal; and a bed of very fine shavings of some wood which abounds in turpentine, is one of the easiest and most effectual means of banishing them from dogs. Fleas are specially parasitical on dogs, and often give them great torment, and render them obnoxious and disgusting to human beings. The swimming or washing of dogs with the view of destroying the fleas is in itself useless; yet it temporarily drowns or disables them, and renders them easy of capture by means of a small-toothed comb. A pretty good remedy, closely akin in its mode of action to the use of turpentine, is to rub the dogs, once or twice a-week, with finely pulverized resin.

A West Indian co-species of the flea, known popularly as the chigoe, and scientifically as *Pulex peletrans*, enormously exceeds the flea in the infliction of torture and disease. "This minute insect penetrates the skin, and, almost without being felt, insinuates itself generally under the nails of the toes or beneath the skin and flesh; there it enlarges to the size of a pea, causing a most disagreeable itching. In process of time, a small pustule appears, filled with multitudes of its eggs; and from this, when it breaks, are dispersed thousands of young, which in course of time create ulcerations, resulting in most calamitous and sometimes even fatal consequences. It is usual, when the presence of a chigoe is suspected by the attendant itching and redness, to have the parasite extracted. This is done by means of a sharp-pointed needle, and very cautiously, so as to enlarge the wound, and at the same time prevent the chigoe from being crushed in it. Walton states that a Capuchin friar, in order to study the history of the chigoe, permitted a colony to establish themselves in his feet; but before he could accomplish his object, his feet mortified and had to be amputated."—[Knight's Museum of Animated Nature.]

FLEABANE,—botanically *Conyza*. A genus of plants, of the thistle division of the composite order. The squarrose species, *Conyza squarrosa*, is a biennial weed of the chalky pastures of England. Its root-leaves are large, hairy, oblong, and pointed, and grow near the ground; its stems rise from among the root-leaves, divide into several branches, and have a height of 2 or 2½ feet; its stem-leaves are alternate, oblong, and smaller than the root-leaves; its flowers grow in round bunches at the top of the stems, and have a dirty yellow colour; and its seeds are oblong and downy, and, if allowed to scatter, send up young plants in spring.—The fragrant fleabane, *Conyza odorata*, is a tender, evergreen, purple-flowered, undershrub of about 2 feet in height, and was introduced to Britain about 90 years ago from India.—Upwards of 40 other species, some shrubby and some herbaceous, have been introduced to our botanical collections; and about 20 additional species have been described.—The name fleabane alludes to the supposed noxiousness of the indigenous species to fleas.

FLEA-BEETLE,—scientifically *Haltica*. A tribe of mischievous, saltatory, herbivorous insects, of the coleopterous order. All were comprised by Linnæus in the single genus *Altica;* but they are distributed by modern entomologists into eight genera,—*Haltica*, with the hinder tibiæ undentate, the hinder tarsi short, and the thorax narrower than the wing-cases,—*Mantura*, with the hinder tibiæ and the hinder tarsi the same as in the preceding, and the thorax of the same breadth as the wing-cases,—*Sphæroderma*, with the antennæ simply-jointed,—*Mniophila*, with the antennæ unequally-jointed,—*Thyamis*, with the hinder tarsi elongate, and inserted at the apex of the tibiæ,—*Macrocnema*, with the hinder tarsi elongate, and inserted remotely from the apex of the tibiæ,—*Chætocnema*, with the hinder tibiæ dentate, and the head prominent,—and *Dibolia*, with the hinder tibiæ spinous, and the head drawn within the thorax. The bodies of the first and the second of these genera are oblong-ovate; and those of the six other genera are hemispherical. These characters, though seemingly minute and technical, are practically serviceable in enabling a close observer of garden and field crops to identify the precise depredators which he may happen to see at work upon them, and to distinguish the exceedingly mischievous from the comparatively harmless.

All the flea-beetles are herbivorous; most prey upon cruciferous plants; and some feed on several species, while others feed upon only one. Most do not exceed a line in length; and scarcely any exceed two lines. The covering or crust of most is hard, polished, and minutely punctured; and that of many is adorned with very brilliant colours. All have the thighs of their hinder legs much thickened, and possess the power of making comparatively great leaps; and no other indigenous beetles have a similar power except a few of the weevils,—and these are readily distinguishable from the flea-beetles by their elongated rostrum. Many of the species of flea-beetles work much havoc upon the young cruciferous plants of our fields and gardens; and, in particular, *Haltica oleracea* devastates the leaves of cabbage, broccoli, and some other brassicas; and *Haltica nemorum*, the notorious turnip-fly, is well-known, for its depredations upon the young turnip crop, as one of the most formidable insect-enemies of both the farmer and the gardener. See the article Turnip-Fly.

FLEAM. See Bleeding.

FLEAWORT. Several species of hardy herbaceous plants, principally of the composite order. The common or small fleawort, *Inula pulicaria*, called by Gærtner *Pulicaria vulgaris*, belongs to the thistle division of composites, and is an annual weed of moist heathy grounds in some parts of England. It is yellow-flowered, has a height of about a foot, and blooms in autumn; and has the reputation of being able to kill fleas with its smell.—The dysentery fleawort, *Inula dysenterica*, called by some botanists *Pulicaria dysenterica*, is a perennial-rooted weed of clear ditches, roadside ponds, and other watery places of England. Its root is creeping, its stem is branched and leafy, and about 18 or 24 inches high; its leaves are woolly and glutinous, and emit an aroma somewhat similar to that of peaches; and its flowers have a bright yellow colour, and bloom in August and September. This plant has diuretic properties, but acquired its specific name from a story told by General Keith of its having once cured a Russian army of dysentery.—The samphire-leaved fleawort, *Inula crithmifolia*, is an evergreen, yellowed-flowered, two-feet-high, herbaceous weed of the muddy salt-marshes of the sea-coasts of England.—The entire-leaved and the marsh fleaworts, *Cineraria integrifolia*, and *Cineraria palustris*, are perennial-rooted, yellow-flowered, ornamental, indigenous species of the jacobea division of composites. See the article CINERARIA.—The plantain fleawort, *Plantago psyllium*, is a weed-looking annual plant of the south of Europe, and was long ago introduced to our botanical collections.—The popular notableness of these plants, and of some others which share with them the name of fleawort and fleabane, all rests upon their reputed noxiousness to fleas; but most of it is sheer fancy.

FLECKED CATTLE. Pied or piebald cattle.

FLEECE. The woolly coat shorn from the body of a sheep. A primitive and barbarous method of obtaining the fleece was to force a flock through a narrow and rough passage, in order that, by rubbing against one another and against the asperities of the passage, they might denude themselves of their wool; and a later and exceedingly cruel method, which continued till not very long ago to be practised in Orkney, was to catch the animals, and forcibly tear off their wool. The mild and economical method now practised, together with the proper rules for observing it, will be noticed in the article SHEARING OF SHEEP.

A fleece, immediately after being shorn from the animal, ought to be spread unbroken upon a board, carefully examined, thoroughly cleaned of all adhering substances and filthified locks, rendered completely pure and neat, and then folded to a breadth of 2 or 2½ feet, rolled up from the tail to the neck, and tied up in such a manner with the drawn-out neck-wool as to form a tight, neat, compact bundle. Its shorn surface ought to be outside; and this, in consequence of the secretion technically called yolk, exhibits a silvery and lustrous appearance. The fleeces obtained at any one shearing, ought to be carefully assorted according to their different qualities; for, even though the whole flock be of one breed and as nearly as possible homogeneous, the fleeces, in every case, possess considerable varieties of character. Some differ from the others in colour; some may have their wool matted and almost felted like cloth; and some may have suffered deterioration and loss by the partial shedding of their wool. The fleeces of the two sexes, and the fleeces of either sex of different ages, also very widely vary. The average weight of the fleeces produced throughout England, inclusive of those of lambs, is said to be 4¼ lbs. See the articles SHEEP and WOOL.

FLEMINGIA. A genus of tropical, purple-flowered plants, of the hedysarum division of the pea order. Nine or ten species have been introduced to British hothouses, principally from India; and most of these are evergreen under-shrubs,—while two, the prostrate and the procumbent, are evergreen trailers, and somewhat ornamental.

FLESH. The soft solid part of an animal's body. But the name is often applied par excellence to the edible portion, or soft solid part, of such animals as are eaten by carnivorous beasts and used as food by man. Flesh admits of a loose popular classification into fat and lean; and the former of these consists almost wholly of oleaginous principles, with a little cellular tissue; while the latter consists principally of fibrin, with accompaniments of albumen, cellular matter, salts, water, and minute portions of some other substances. The red or white fibres or collections of fiberets, which constitute the characteristic part of muscle or the lean of flesh, are combined with ligament, sinew, nerves, blood, fat, and saline, mucous, and watery secretions. A specimen of muscular or lean flesh was analyzed by Berzelius, and found to consist of 15.8 per cent. of fibrin and nerves, 1.9 of cellular matter, 1.8 of muriate and lactate of soda, 0.9 of phosphate of soda, 0.15 of extractive matter, 2.2 of albumen and colouring matter of blood, 0.08 of albumen holding in solution phosphate of lime, and 77.17 of water and matter lost during the process of the analysis. The lean of flesh, in consequence of its great abundance of fibrin, combines more nutritiousness with ease of digestion than any other nitrogenous substance. See the articles FIBRIN, NUTRITION, and ALIMENTARY PRINCIPLES.

FLESH-FLY. See FLY IN SHEEP.

FLET-MILK. Skimmed milk.

FLIES. See FLY.

FLINDERSIA. A small genus of tender trees, of the bead-tree tribe. The southern species, *F. australis*, is a timber-tree of New Holland, carrying white flowers, and usually attaining a height of 60 or 70 feet. Living specimens of it are now grown in British conservatories.

FLINT. A mineral which occurs of all colours, but generally yellowish and dark grey, commonly in a compact amorphous body, rarely crystallized. It is widely spread throughout the earth, in primitive, secondary and alluvial formations, but especially in lime-stone. This mineral consists of 98 silica, 0.50 lime, 0.25 alumina, 0.25 oxide of iron, and 1.0 loss. Its principal use is for gun-flints, and it is also reduced to a powder, and used in the manufacture of porcelain and glass. The manufacture of gun-flints is exceedingly simple, and a good workman will make 1,000 flints a-day. The whole art consists in striking the stone repeatedly with a kind of mallet, and bringing off, at each stroke, a splinter sharp at one end, and thicker at the other. The splinters are afterwards shaped at pleasure, by laying the line at which it is wished they should break, upon a sharp instrument, and then giving it small blows with a mallet. Large manufactures of gun-flints exist at Muesnes in Berry, in Galicia, and at Avio in the Tyrol.

FLIXWEED,—botanically *Sisymbrium Sophia.* An annual-rooted, yellow-flowered, cruciferous weed, of the waste grounds of Britain. Its root is small and tapering; its stem is erect, branched and leafy; its flowers are small, and appear in July; and its pods are erect, bearded, numerous, and about an inch in length. The plant has a slender and delicate appearance; and it formerly possessed a high but altogether factitious celebrity for the healing of wounds and the cure of dysentery.

FLOAT. A raft of timber buoyant on water; also, an artificial irrigation; also a paring of the sward of a piece of grass-land. A float or float-board likewise means one of the propelling-boards upon the rim of the water-wheel of a mill, or of the paddle of a steam-vessel.

FLOATING OF MEADOWS, or FLOATING OF LAND. See IRRIGATION and FLOODING OF LAND.

FLOCK. Any number of sheep, or of other domesticated gregarious animals, which feed together, or are under the care of one person.

FLOOD. An overflow of water upon land. A flood may be a vast and devastating overflow, occasioned by the subsidence of land or the extraordinary rise of the sea or great lakes; or it may be an extensive and prolonged yet gentle overflow, occasioned by the winter-swelling of a river over low and spreading banks, and practically possessing the character of a temporary or seasonal lake; or it may be a sudden and violent irruption upon low grounds, occasioned by the bursting of the barriers of a lake situated upon higher ground; or it may be a brief but violent overflow, occasioned by great and sudden rains within the basin of a river, and possessing in all respects the character of a freshet. The two great objects of embankments are to reclaim land from the second kind of flood, and to protect it from the fourth. See the article EMBANKMENT.

FLOODING. A morbid and copious flow of blood from the womb. It is frequently occasioned in cows by forcible extraction of the fœtus in parturition, and especially by the artificial extraction of a long-retained placenta. The best remedy is a constant application to the loins of very cold water, or of a nitrous solution in the proportion of a pound of saltpetre to a gallon of water; and this application is most facilely made by means of cloths very frequently dipped in the liquid.

FLOODING OF LAND. An operation intermediate in character between warping and irrigation. It resembles these operations in laying a piece of low flat land for some time under water; but it differs from warping in using only the downward water of land streams, and from irrigation in having the water of the flooding, not in a flowing state, but wholly or nearly stagnant. It operates principally by the deposition of silt or fine alluvium, and is a powerful means of reclaiming and fertilizing various kinds of low-lying lands. A flat of about 240 acres at the head of Loch-Ken in Kirkcudbrightshire has long been rendered, by means of flooding, one of the richest spots in Scotland. Some parts of it, without receiving any fertilizing matter whatever except the silty deposit from the flooding, have been cropped with grain for at least 25 years in succession; and other parts have, year after year, produced hay at the rate of 3 tons per acre. Many meadows upon the margins of rivers in both Scotland and England have long been annually enriched, and constantly maintained in a luxuriant condition, by means of natural flooding during the months of winter; but not a few of these are quite unprotected by embankments, and unprovided with any appliances for regulating the flooding, and, in consequence, often sustain severe injury from freshets in summer and autumn. An artificial method of flooding, when the stream is small and the lower part of the meadow is narrow, is to arrest the water by means of a dam, and to let it all off as soon as it is supposed to have made a sufficient deposit of silt; and this was for some time practised in Britain under the technical name of "floating upwards;" and though discontinued after the introduction of the improved method of irrigation by floating ridges, it still deserves a place in the practices of georgy, and may prove effective and valuable in many a case in which irrigation would be far too expensive to be economically adopted.

Tracts suitable for flooding are flats, traversed or commanded by running water, easily dammed across their lower end, and capable of being readily overflown athwart their whole surface; and particularly suitable tracts occur in all land-locked, hard-bottomed bogs or peaty moors, situated on a lower level than the adjacent streams or springs. Water impregnated with bitumen or iron, or carrying off the drainage of bogs would be mischievous rather than beneficial; but any water issuing from calcareous strata, or trotting along a pebbly path, or only so far saline as to combine softness with limpidness, richly and rapidly improves poor meadow-land, or low, firm bog-land, or thin and hungry moorish-land, by making deposits of thoroughly pulverulent alkaline silt, by decomposing and carrying away the antiseptic principles of bog plants, and starving coarse and wiry herbage, and promoting the growth of the tender, succulent, and nutritious grasses. But as the destruction of coarse herbage, in the case of all the poor or waste lands peculiarly suitable for this operation, requires to be vastly more aimed at than the immediate production of fine herbage, the flooding ought to take place, not in winter when the forces of decomposition are comparatively inert, but in summer when heat and light and electricity will cooperate with the water in rapidly killing the coarse plants and destroying the antiseptic principles.

FLORA. A technical name for a list or systematic view of all the known plants of a district, a country, or the whole world. A Flora of Britain, for example, is a list or systematic view of all the known plants in Britain; and this may be either a natural Flora, an artificial Flora, or a commercial Flora,—the first comprising all the known indigenous plants, the second comprising also all introduced exotics, and the third comprising all of both classes which are sold, in any form, by native nurserymen and seedsmen.

FLORET. One of the numerous little flowers which constitute the compound aggregate, or entire flower, of a composite plant. The florets of the ray, as in the daisy, are ligulate; and the florets of the disc, as in the same plant, are tubular.

FLORICULTURE. The art of cultivating ornamental phænogamous plants, with a special view to the finest forms, the most beautiful tints, and the improved habits of their flowers.

FLOUR. The farina of the grain of wheat, barley, or other corn separated from the husk, and reduced to a state of fine powder.

The first part of the process of converting grain into flour consists in shelling and winnowing; and this is performed by means of a shelling cylinder of plate-iron, and of a common winnowing machine. The cylinder rubs off the ends of the grain, thrashes off the husk, and separates all extraneous or adhering foreign matters; and the winnowing machine blows away the chaff, the bits of straw, and a great mass of small or pulverized impurities in the form of a fine, dark-coloured, suffocating dust. The quantity of shelled and winnowed refuse from even the cleanest-looking wheat would astonish any person who has never witnessed the process; and sometimes a conical heap of upwards of two feet in height is accumulated from the deposits of the winnowing-machine in the course of three hours. The cylinder ought not to revolve, but ought to be furnished in its interior with very rapid-going scutchers; the winnowing-machine ought to have a very powerful blast, and to be furnished with a wire sieve for separating sand, earthy matters, and small heavy seeds of weeds; and the grain ought to pass very slowly from the hopper into the cylinder, and very slowly also from the cylinder to the winnowing-machine, and to be spread out in a thin and equable manner. But in some places, particularly in Ireland, two shelling cylinders are used, of equal size and similar construction, both revolving and placed in an inclined position, and punched with holes toward the interior, but the second with smaller holes than the first, and effecting a better separation of sand, earth, chaff, and seeds of weeds. This system of two cylinders might seem to be required by the very foul condition in which those who practise it frequently receive the grain; but it is really not more effective than the system of a single properly constructed and well-appointed cylinder.

The shelled and winnowed grain is next passed through a hopper or otherwise, to be ground between two revolving mill-stones, set at the precise nearness to each other to reduce it to the requisite degree of pulverization, and it acquires so much heat in the act of grinding, that it must be instantly conveyed to a well-ventilated cooling-room, spread uniformly out upon the wooden floor, turned frequently over with a wooden shovel, and thus freed with all possible speed from the whole of its acquired heat. Flour excessively heated by bad grinding is technically designated "killed," and feels between the fingers like hair-powder, and becomes puffy and frothy in the heap, and is scarcely fermentable by any means short of an abundant intermixture either of prime wheaten flour or potato starch; and even flour which is but moderately or not unduly heated in the grinding, if allowed to continue hot for a little time in the heap, will become quite unfit for the uses of the baker. The proper mill-stones are a single pair of prime French buhr-stones; and they should not be set closer than to convert the grain into a meal which feels smooth when rubbed on the side of the forefinger by the thumb. But in most of the flour-mills of Ireland, the shelled and winnowed grain is first fed thickly in between two buhr-stones, set at such a distance from each other as to cut it all into the coarse kind of meal technically called "sharps;" it is then spread upon a floor till it becomes cool; it is next fed very thinly in between two buhr-stones, set so close to each other as to evolve a strong sulphureous smell from the mutual friction of their surfaces; it comes out from between these stones in a state of such excessive heat that the hand can scarcely endure it; and it is then spread out on another floor, and made to cool as rapidly as possible by means of constant turning. In proper grinding with only one pair of well-set mill-stones, the bran peels off in thin flakes from the entire grains, feels light in the hand, and, when thrown up into the air, gyrates and falls waveringly like minute pieces of fine paper; but in the method of grinding which cuts all the grain into "sharps" before reducing any of it to powder, the bran is cut into fragments along with the grain, adheres for a time to the angular little masses of the "sharps," ultimately takes away with it adhering portions of the farina, feels heavy in the hand, and, when thrown into the air, falls almost as right down as oatmeal. The quantity of the kernel of the grain carried off by adherence to this heavy bran is so great as to occasion a considerable or even serious deduction from the profits of the flour; the use of two pairs of mill-stones instead of one, and the close and rapid abrasion of the second pair, also occasion some loss; and the excessive heating of the flour by the close action of the second pair of mill-stones more or less "kills" every sample of it, deteriorates its quality, and induces or almost compels the great majority of the Irish bakers to intermix it freely with potato starch.

The flour, after being ground and cooled, requires to be dressed or bolted; and, for this purpose, it passes by a hopper from the cooling-room to the dressing-cylinder, and is there brushed through wire-cloth of different sizes, and so separated into its different parts,—whether of firsts, seconds, thirds, and bran,—or of fine flour, second flour, third flour, coarse bran, and fine bran,—or of fine flour, seconds, fine middlings, coarse middlings, bran, twenty-penny, and pollard. See the article Bolting. One passage of the flour through a bolting-engine, covered with the size of wire-cloth adapted to the various kinds of desired flour and bran, and the engine remaining stationary while the brushes within it move with rapidity, is all that is requisite for a thorough dressing of the flour. But in most of the Irish flour-mills, the flour is passed through a bolting-engine which revolves on its axis, and sends the thirds flour and all the bran through the coarsest-sized wire-gauze; the fine flour is then put through a similar engine, covered with the finest kind of wire-gauze, and divided into very fine first flour and rather fine second flour; the fine flour is sacked up from the spout of the engine, and consolidated by means of a lever and chains lifting up the sack and beating the bottom of it against the floor; and the bran is passed through a separate bolting-engine specially adapted to itself, and separated into fine and coarse. This operoseness of bolting is both absurd and wasteful; and the products of it are by no means worthy of its excess of care. "The fine flour," says a writer in the 4th volume of the Q. Journal of Agriculture, "is very fine in Ireland; but in the dressing, it has not a sufficient quantity in it of what passes among the seconds, which makes the latter finer than it ought to be, and of course a loss is thereby incurred. Fine, however, as the flour is, it is mixed with minute specks of bran, which is not to be wondered at, considering how the wheat is hashed down in the first grinding. We were at first astonished to find the finest wheat selling in Ireland at only 10s. 6d. to 12s. per cwt., which is about 50s. per quarter, when the same quality of wheat was selling in Britain at the same time for 58s. and 60s. per quarter. But after seeing the filthy state of the stocks of wheat delivered at the flour-mills, and the quantity and weight of trash of all kinds which were taken out of it in the cleaning process, and the two-handed work which it had to undergo in the mill, our astonishment ceased; for unless the wheat were bought at a low price by the flour-millers, they could not afford to sell their flour in the English markets at the English prices."

British wheat, even when grown from the best varieties of seed and cultivated in the most scientific and workmanly methods of agriculture, often greatly varies, as to both quality and quantity, in its yield of flour. Some grain has a thicker husk than others, and so contains a larger proportion of bran; grain cut several days before being ripe yields a whiter and finer flour than the same grain cut in full maturity; flour from grain of English growth is supposed to be more absorbent, to require more water for being brought into the state of dough, and to produce about 100 lbs. more of bread per ton than flour from the same grain of Scottish growth; and one sack of flour, without possessing any superiority of quality recognizable by the rules and tests of bakers, is sometimes found to produce two or three more quartern loaves than another sack. But bakers cannot even detect the differences of flour manufactured from the opaque and the flinty varieties of wheat; and in spite of a purchasing of ready-made flour being their simplest and apparently cheapest method of procedure, they often find it their interest to buy wheat, and get it ground for themselves, and even to bolt it on their own premises.

The English millers usually distribute the pulverized grain into seven different classes,—fine flour, in the proportion of about 48 parts to 120 of the entire grain,—seconds flour, in the proportion of about 4 parts,—fine middlings, in the proportion of about 2 parts,—coarse middlings, in the proportion of about 1 part,—bran, in the proportion of about 24 parts,—twenty-penny, in the proportion about 24 parts,—and pollard, in the proportion of about 17 parts. But the Scottish millers usually have only five classes, fine flour, second flour, thirds or sharps, fine bran, and coarse bran. Both the fine and the second are prepared in very various degrees of fineness, and are therefore capable of considerable subclassification. The finest possible is prepared by taking out only a very small proportion of the bulk of the farina; and this is used for making the choicest kinds of pastry and fancy breads. The second flour of any grinding whence the finest possible has been taken possesses a quality intermediate between the ordinary fine and the ordinary seconds; and either makes a coarse specimen of fine loaf, or a fine specimen of coarse loaf. Fine flour made out of a large proportion of the bulk of the farina, closely resembles this intermediate kind; and the seconds flour taken after it, is necessarily reduced in quantity and very coarse in quality. Any proportion of fine flour, from the very small proportion of the finest possible to the very large proportion of resemblance to ordinary seconds, may be taken out of the entire bulk of the farina, simply by diminishing or enlarging the normal space of the fine portion of the wire-cloth, by means of a hinged board attached to the under part of the bolting-engine. The thirds or sharps consist of the central or residual portions of the grain, and escape from between the mill-stones, and are used for making biscuits. The fine bran is used for feeding pigs and poultry; and the coarse bran is used for mixing with horse-corn and for making bran-mashes for horses and cattle. The whole bulk of the grain, with the exclusion simply of the coarse bran, is sometimes ground promiscuously down, and called whole meal or overhead flour; and this is probably the healthiest possible form in which the farina can be prepared by the miller; and it is often made into an excellent, sweetish-tasted, dark-coloured, and very coarse household bread, preposterously called bran-loaf. A flour only one degree less coarse than this, or comprising all the contents of the grain except the coarse bran and the fine bran, likewise makes a sweet coarse bread. Various substances are used by unprincipled manufacturers and venders for adulterating flour. See the articles BREAD and ADULTERATION.

FLOWER. The reproductive organ of a phænogamous plant. All flowers are temporary, and some are exceedingly fugitive; yet they aggregately constitute the chief glory of the vegetable creation; and multitudes are superlatively interesting for the delicacy of their organization, the elegance of their forms, and the brilliance or beauty of their tints. They are by far the most refined portion of plants; and possess a mighty power to arouse the curiosity, to excite the admiration, to charm the fancy, and to thrill and fascinate our sense of the beautiful; and so completely do many of them fill the imagination of all beholders as popularly to give their names to the entire plants on which they grow. "A love of these beautiful things of nature," says the most distinguished female poet of America, "has been sometimes assumed as a criterion of the health of the mind. Those who are under the habitual influence of evil tempers do not approximate to the spirit and language of flowers. In vain do they reach forth their sweet, clustering blossoms—envy, hatred, and malice are beyond the reach of such charmers, 'charm they never so wisely.' But he who, amid the care and weariness of life, finds daily an interval or a disposition to commune with the dew-fed children of heaven, to devise their welfare, and shelter their purity, has not yet been injured by the fever of political strife, the palsy of the heart, or the eating gangrene of the inordinate desire of riches. Err they not therefore, who consider a taste for the charms of nature a waste of time? The railroad machinery of a jarring world, bridging its abysses, and tunnelling the rocks of political ambition,—her steam boats rushing to the thousand marts of wealth, silence with their roaring funnels its still small voice. But let it be heard by those who meditate at eventide, when the rose closes its sweet lips, and the tired babe is lulled on the breast of its mother. Let it be a companion to those who, in the morning-prime, walk forth amid the dewy fields, loving the beauty of the lily which Omnipotence stooped to clothe, and from whose bosom, as from a scroll of heaven, the Redeemer of man taught listening multitudes the lessons of a living faith."

Some flowers issue from the roots of the plants which produce them; some from the stem; and some from the leaves; but the great majority issue from the extremity of the branches. Those from the root are said to be radical; those from the stem, circular or whorled; those from the leaves, foliary; and those from the branches, rameal. Flowers, as to their mode of attachment, are either sessile or pedunculate; and, as to their direction, are either erect, drooping, nodding, inverted, fastigiate, spreading, all-sided, or unilateral. The parts of flowers are the calyx, which is unessential and not always present,—the corolla, which also is unessential and not always present, but which generally is the seat of all the chief beauty of the flower,—and the stamens and pistils, which are essential or constitute the immediate organs of reproduction, and whose numbers and mode of attachment also form the most important characters for the construction and arrangements of all systematic botany. See the articles CALYX, COROLLA, STAMEN, and PISTIL.

The colours of some species of flowers are uniform and unalterable; those of others usually possess two or more invariable tints or sets of tints, constituting so many varieties of the species; and those of a few, particularly of some species of the brilliant and pet beauties technically called florists' flowers, are exceedingly numerous, and often wonderfully variable and sportive. Species of different colours, even when all are invariable, occur, in multitudes of instances, in the same genus. The mere colour of flowers, therefore, seldom possesses the rank of a botanical character, so as to afford to the learner any criterion of genera or species. The elaboration of the various colours and tints must constitute one of the most complex and beautiful of the processes of natural chemistry; but it proceeds on too filmy a scale, and under too recondite conditions, to have been hitherto detected by the researches of chemical phytology. The tints of some flowers, as may be familiarly seen in many hybrid violets, fade or change on the plant under the play of sunshine; and those of many either pass into other tints or wholly perish, soon after the flowers are cut or gathered.

Double flowers are such as have a duplicature, triplicature, or multiplicity of their normal petals; and thoroughly double flowers, such as those of the best kinds of dahlias, camellias, roses, ranunculuses, carnations, pinks, stocks, wallflowers, hepaticas, rockets, polyanthuses, and other species of the choicest flowers, possess an absolute profusion of petals, and exhibit them from centre to circumference of all their natural space. All doubleness is supposed to result from an excess of nourishment and warmth, or from a profuse luxuriance and plethoric energy of growth in the plants at the time of flowering; and it is always accompanied, in its fullest and even middle-rate forms, with a want of pistils and stamens, the parts of the flower essential to natural or seminal reproduction, and is therefore regarded by botanists as a monstrosity. In all such perennial plants as are propagable by offsets, division of the roots, tubers, cuttings, layers, or buddings, the habit of double-flowering is, in all ordinary circumstances, conveyed into the young plants by these methods, so as to be quite certain of development; but in plants which are propagated by seeds, whether they be annual, biennial, or perennial, it is conveyed only by the same kind of recondite agencies which originated it, and is always contingent and doubtful of development. Some plants, such as *Anemone hortensis*, possess a tendency of producing double flowers from seed in the rare proportion of one plant in several hundreds or a thousand; and others, such as stocks, China asters, and French and African marigolds, possess a tendency, under favourable circumstances, of producing them in the proportion of one-half or considerably more than one-half of all the plants raised. A notion prevails that seed from a plant which has grown by the side of a double-flowered plant possesses a superior power of producing the double-flowered habit; but this is mere fancy. Sound, plump, properly-ripened seed, no matter how grown, is no doubt one condition of eminent success in producing double-flowering plants; and the other conditions are the particular circumstances of soil, climate, and culture, be they what they may, which educe extraordinary vigour and luxuriance in vegetation, particularly at the period of the formation and development of the flower-buds.

Most of the many flowers which are used for medicinal purposes, or for the distillation of volatile oils and perfumers' essences, ought to be gathered in full bloom; but roses do best to be gathered in bursting-bud or at the commencement of bloom, and tussilago and other pappous composites in the earliest stage of bloom. Most medicinal flowers require to be dried with all possible speed; and many, such as those of wormwood, melilot, and lesser centaury, may be made up into small parcels and suspended in constant exposure to the air; but those of liliaceous plants are incapable of being dried without perishing, and some which abound in volatile oils and odours part with most or all of their aroma and perfume in drying. The calyx of the pomegranate flower is the principal part cared for; and all the parts of most of the labiate flowers, together with even their peduncles and spike-stems, are of use; but only the corolla, the pistils, and the stamens of most flowers are taken; and even the corolla in some instances, as in that of the crocus, is thrown away.

Of the various methods practised for prolonging the beauty and freshness of cut flowers, one of the newest and most surprising, though efficacious perhaps in the case of only certain species, is the impregnation of the water containing the flowers with a little camphor. The power of this method upon flowers of the Leriodendron is to prolong them to twice the period of their natural time in mere water, and to render them fully more brilliant and expansive than in their growing state upon the tree.

FLOWER-FENCE,—botanically *Poinciana*. A genus of tender ornamental shrubs, of the cæsalpinia division of the leguminous order. The very fair species, *Poinciana pulcherrima*, is a native of both Indies, and was introduced to Britain toward the close of the 17th century. It has long been used as a hedge-plant in Barbadoes, and for that reason is called Flower-Fence; and it is also popularly known in other parts of the West Indies under the name of Spanish Carnation. Its stem is erect, straight, 10 or 12 feet high, and sometimes about 4 inches in diameter; its bark is smooth and grey; its branches deflect from the upper part of the stem, have a spreading habit, and are armed at each joint with two short, strong, crooked spines; its leaves are doubly pinnate, each consisting of 6 or 8 pairs of simple pinnate members, and the lowest of these pairs comprising 4 or 5 sets of leaflets; its leaflets are three-fourths of an inch long and nearly half an inch broad, and have a light green colour, and emit a strong odour when bruised; and its flowers grow in loose spikes, with the outline of a kind of pyramidal umbels, at the extremity of the branches, and have an agreeable fragrance, and are elegantly variegated with deep red or orange, yellow, and some spots of green, and usually bloom from June till September. This plant is greatly prized within the tropics for its beauty; and its leaves have been used in the West Indies as a medicinal substitute for those of senna. A variety of it with yellow flowers, *P. p. lutea*, was introduced to Britain about the same time as the normal plant. Three other species, the tall, the noble, and Gillies's, have been introduced; and the last of these, a yellow-flowered shrub from South America, possesses the double recommendation of being very beautiful, and of requiring no greater heat than that of the conservatory.

FLOWER-GARDEN. See GARDEN.

FLOWER-GENTLE. See AMARANTH.

FLOWERING-ASH. See ASH (FLOWERING).

FLOWERING-RUSH. See BUTOMUS.

FLUELLIN. See SNAPDRAGON.

FLUID. An appellation given to all bodies which yield, without separation, to the slightest pressure, easily move among themselves, and accommodate themselves to all changes of position, so as always to preserve a level surface. All fluids, except those in the form of air or gas, are incompressible in any considerable degree. All fluids gravitate or weigh in proportion to their quantity of matter, not only in the open air, or *in vacuo*, but in their own elements. Although this law seems so consonant to reason, it was supposed by ancient naturalists, who were ignorant of the equal and general pressure of all fluids, that the component parts, or the particles of the same element, did not gravitate or rest on each other;

so that the weight of a vessel of water, balanced in air, would be entirely lost when the fluid was weighed in its own element. The following experiment seems to leave this question perfectly decided:—Take a common bottle, corked close, with some shot in the inside to make it sink, and fasten it to the end of a scale beam; then immerse the bottle in water, and balance the weight in the opposite scale; afterwards open the neck of the bottle, and let it fill with water, which will cause it to sink; then weigh the bottle again. Now it will be found that the weight of the water which is contained in the bottle is equal to the difference of the weights in the scale, when it is balanced in air; which sufficiently shows that the weight of the water is the same in both situations. As the particles of fluids possess weight as a common property of bodies, it seems reasonable, that they should possess the consequent power of gravitation which belongs to bodies in general. Therefore, supposing the particles which compose fluids to be equal, their gravitation must likewise be equal; so that in the descent of fluids, when the particles are stopped and supported, the gravitation being equal, one particle will not have more propensity than another to change its situation; and, after the impelling force has subsided, the particles will remain at absolute rest. From the gravity of fluids arises their pressure, which is always proportioned to the gravity. For if the particles of fluids have equal magnitude and weight, the gravity or pressure must be proportional to the depth, and equal in every horizontal line of fluid; consequently, the pressure on the bottom of vessels is equal in every part. The pressure of fluids upwards is equal to the pressure downwards, at any given depth. For, suppose a column of water to consist of any given number of particles, acting upon each other in a perpendicular direction, the first particle acts upon the second with its own weight only; and, as the second is stationary, or fixed by the surrounding particles, according to the third law of motion, that action and reaction are equal, it is evident that the action or gravity, in the first, is repelled in an equal degree by the reaction of the second; and, in like manner, the second acts on the third, with its own gravity added to that of the first; but still the reaction increases in an equivalent degree, and so on throughout the whole depth of the fluid. The particles of a fluid, at the same depth, press each other equally in all directions. This appears to rise out of the very nature of fluids; for, as the particles give way to every impressive force, if the pressure amongst themselves should be unequal, the fluid could never be at rest, which is contrary to experience; therefore we conclude that the particles press each other equally, which keeps them in their own places. This principle applies to the whole of a fluid as well as a part. For if four or five glass tubes, of different forms, be immersed in water, when the corks in the ends are taken out, the water will flow through the various windings of the different tubes; and rise in all of them to the same height as it stands in the straight tube: therefore the drops of fluids must be equally pressed, in all directions, during their ascent through the various angles of the tube; otherwise the fluid could not rise to the same height in them all. From the mutual pressure and equal action of the particles of fluids, the surface will be perfectly smooth, and parallel to the horizon. If, from any exterior cause, the surface of water has some parts higher than the rest, these will sink down by the natural force of their own gravitation, and diffuse themselves into an even surface.

FLUIDITY. The state of bodies when their parts are very readily moveable in all directions with respect to each other. Many useful and curious properties arise out of this modification of matter, which form the basis of the mechanical science called *hydrostatics*, and are of considerable importance in chemistry. But the attention of the chemist is chiefly directed to the state of fluidity, as it may affect the component parts of bodies. A solid body may be converted into a fluid by heat. The less the temperature at which this is effected, the more fusible the body is said to be. All fluids, not excepting the fixed metals, appear, from various facts, to be disposed to assume the elastic form, and this the more readily the higher the temperature. When a fluid is heated to such a degree that its elasticity is equal to the pressure of the air, its interior parts rise up with ebullition. The capacity of a dense fluid for caloric is greater than that of the same body when solid, but less than when in the elastic state. If this were not the case, the assumption of the fluid and elastic state would be scarcely at all progressive, but effected, in most cases, instantly as to sense. The state of dense fluidity appears to be more favourable to chemical combination than either the solid or elastic state. In the solid state, the cohesive attraction prevents the parts from obeying their chemical tendencies; and, in the elastic state, the repulsion between the parts has, in a great measure, the same effects.

FLUIDS (Motion of). The motion of fluids, viz., their descent below or rise above the common surface or level of the source or fountain, is caused either, 1. by the natural gravity or pressure of the fluid contained in the reservoir or fountain; or, 2. by the pressure or weight of the air on the surface of the fluid in the reservoir, when it is, at the same time, either taken off or diminished, on some part, in aqueducts or pipes of conduit; 3. by the spring or elastic power of compressed or condensed air, as in the common water engine; 4. by the force of pistons, as in all kinds of forcing pumps, &c.; 5. by the power of attraction, as in the case of tides, &c.

FLUKE,—scientifically *Fasciola Hepatica*, or *Distoma Hepaticum*. An entozoon or parenchymatous parasite, of the acritous division of the world of animated beings. It is popularly classed with parasitical worms, but has a curious shape similar to that of a mimic sole or of the seed of the common gourd. It particularly infests the liver of quadrupeds, burrowing into every part of it, and swimming about in the bile. It occurs in mice, rats, and other vermin; it sometimes infests asses, mules, and horses; it occurs still more frequently in cattle; and it is particularly common in goats, deer, and sheep, and occurs more or less in almost all other domesticated quadrupeds. How it is propagated, or finds entrance into the animals, is not known; but the probability is that its ovules are so minute and pellucid as to be undetectable by any of our tests or instruments,—that they float, like the ovules of infusorial animalcules, abundantly and freely in the atmosphere,—and that they are either inhaled with the breath or taken in with the food, and are hatched into life on their obtaining a suitable nidus in the liver. Yet the fluke seldom or never occurs in either saline air or tolerably dry situations; it exists coincidently with moist pastures, and abounds in the atmosphere of fresh-water marshes; and it rarely attacks animals in a state of perfect health, but more or less accompanies all morbid diseases of the liver, and abounds in jaundiced cattle, and is dreadfully multitudinous in rotted sheep. See the articles Jaundice and Rot. "Several hundreds of flukes," says Clater, in reference to rot in sheep, "are sometimes contained in one liver. The liver is so diseased and corrupted, that if an attempt is made to boil it, instead of becoming hardened, it falls all to pieces, or is in a manner dissolved." "There is no case on record," says Youatt in reference to jaundice in cattle, "in which it has been proved by examination after death, that the fluke-worm has mechanically obstructed the passage of the bile, and thus caused both the yellowness and the spasm; yet it can easily be imagined that this will sometimes occur. There are no peculiar symptoms to indicate the existence of these worms; for they have never been voided from the mouth or the anus. Their presence could only be guessed at from the nature of the pasture, or from their having been found in other beasts of the same herd." The only known preventives of flukes in the animals of the farm are dryness of pastures, the use of common salt, and whatever tends to maintain the hepatic system in a state of perfect health.

FLUOR, or Fluor-Spar. The crystals and crystalline masses of this mineral, when so cleaved as to improve all its cleavages in an equal degree, result in regular octahedrons, which figure is therefore assumed as the primitive form of the species. It presents an extensive variety of crystals, of which the cube and the cubo-octahedron are the most frequent, the primitive form being comparatively rare. They vary, in size, from very minute to several inches in diameter. Lustre, vitreous; colour, white, though not very common, and seldom pure; more generally wine-yellow or violet-blue. Among its brightest colours are emerald and pistachio-green, sky-blue, rose-red and crimson-red. Very dark blue colours, bordering on black, and probably owing to foreign admixtures, sometimes occur. Sometimes different shades of colours are disposed in coats parallel to the faces of the cube, or symmetrically distributed along the edges or solid angles of crystals. Translucent as well as transparent; brittle; hardness, between apatite and arragonite, and capable of being scratched with ease by the knife; specific gravity, 3.14. Besides occurring in well-defined crystals, it often appears massive, in which case the composition is columnar, the particles being of considerable size, sometimes diverging, but more often forming a curved, lamellar composition. The composition is also granular, the individuals being of various sizes. It is likewise, though more rarely, impalpable, the fracture becoming flat, conchoidal and splintery, and the surface of fracture being scarcely glimmering. Fluor is composed of 72.14 of lime, and 27.86 of fluoric acid. Before the blow-pipe, it decrepitates, and becomes phosphorescent, but loses its colour, and melts at last into an opaque globule. It phosphoresces likewise, if thrown upon ignited charcoal or heated iron. The light emitted is generally purple, though some varieties afford bright green colours. In consequence, they have received the name of *chlorophane*, or *pyro-smaragdus*. A variety of this latter kind, from Ekaterineburg, in Russia, phosphoresces simply from the warmth of the hand. If fluor be exposed to too high a temperature, it loses the property of again showing this phenomenon. Sulphuric acid decomposes the powder of the mineral; fluoric acid is disengaged in a gaseous state, and corrodes glass. Several varieties, particularly the sky-blue and rose-coloured ones, lose their colour on exposure to the light. Fluor is not unfrequently found in beds, as at Alston Moor and Castleton, in England; more generally, however, it occurs in veins in argillaceous schist and secondary limestone, accompanied by galena-blende, calcareous and pearl spars, heavy spar, quartz, bitumen and clay, as at several places in Cumberland and Durham, of the same country. It also frequents primitive rocks, accompanying tin-ore, mica, apatite and quartz.

The uses of fluor are numerous and important. It is employed as a flux in the reduction of various ores, from which circumstance the name *fluor* has been derived. The fluoric acid, disengaged from it by means of sulphuric acid, is used for corroding and etching upon glass. Formerly the finest specimens were cut and worn as gems; but their inferiority in point of hardness, being considerably below that of the artificial gems, has brought them into disuse. It still continues, however, when obtainable in masses of sufficient dimensions, to be wrought into various extremely ornamental objects, such as vases, basins, obelisks, &c. This manufacture is confined to Derbyshire, no other part of the world affording fluor sufficiently firm and tenacious for the purpose, and which is, at the same time, possessed of fine colours. The work is performed on a lathe turned by water, the foot-lathe being much more liable to produce fractures in the piece worked, by its want of steadiness. The tool employed, at first, is a piece of the best steel; after which a coarse stone is applied, with water, so long as the smoothness is improved by these means; then the finer gritstone, pumice, &c.; till, finally, the article becomes sufficiently smooth to receive emery, with which the operation is completed. The crevices which frequently occur in the masses of fluor, are sometimes concealed by the introduction of galena; and, as this substance is often naturally found with the fluor, it becomes difficult to detect the fraud. In selling the articles, also, it is a frequent practice to moisten them with water, under the pretence of removing dust, which is done to bring out the colours otherwise invisible, and which, of course, disappear as soon as the objects become thoroughly dry.

FLUORIC ACID. This is prepared by mixing pure fluor-spar, in coarse powder, with twice its weight of sulphuric acid, in a leaden or silver retort, and applying heat. The acid distils over in vapour, and must be collected in a receiver of the same metal, surrounded by ice. At the temperature of 32° Fahrenheit, fluoric acid is a colourless fluid, and remains in that state at 59°, if preserved in well stopped bottles; but, when exposed to the air, it flies off in dense white fumes, which consist of the acid in combination with the moisture of the atmosphere. Its specific gravity is 1.0609; but its density may be increased, by gradual additions of water, to 1.25. Its affinity for water is far greater than that of the strongest sulphuric acid. When a drop of it falls into water, a hissing noise is heard, similar to what is occasioned by plunging a red-hot iron into that liquid. Its odour is extremely penetrating, and its vapour dangerous to inspire. When applied to the skin, it instantly disorganizes it, and produces the most painful wounds. It acts energetically on glass; the transparency of the glass is instantly destroyed, caloric is evolved, and the acid boils, and, in a short time, disappears entirely, a colourless gas being the sole product. This gas has received the name of *fluo-silicic acid*, because it is regarded as a compound of fluoric acid and silica. From the strong affinity of fluoric acid for silica, it cannot be preserved in glass bottles; and is therefore kept in vessels of lead or silver. For the same reason, fluoric acid is employed for etching on glass—its only important application. The glass is covered with a thin coat of wax, or is brushed over with a solution of isinglass in water; and, when this is dried, lines are easily traced by a graver. It is then exposed to the action of the acid in the state of gas; the parts of the glass thus exposed are soon eroded, the impression being more or less deep, according to the time during which it is exposed.

Fluoric acid forms salts by uniting with several bases. Five fluates have hitherto been found native; viz., the fluate of lime, or fluor-spar, the fluo-silicate of alumine, or topaz, the fluate of cerium, the double fluate of cerium and yttria, and the double fluate of soda and alumine, or cryolite. The four latter are very rare minerals, but the first is abundant. Potash unites with fluoric acid in two proportions, forming a fluate and a bifluate, the former of which consists of one atom and the latter of two atoms of acid united with one atom of the alkali.

FLUVIALES. A natural order of aquatic plants. It is nearly allied to the orders aroideæ and typhinæ; and is situated on the very verge of the vascular division of the vegetable kingdom, or removed but a single degree from the cellulares. Two of its genera, zostera and ruppia, are very liable to be thought cryptogams, and mistaken for algæ. The order comprises five other genera; and has altogether, within Great Britain, about 30 species.

FLUX. See DIARRHŒA and DYSENTERY.

FLY, or FLY-HONEYSUCKLE,—botanically *Lonicera Xylosteum*. An indigenous, ornamental, deciduous shrub, of the honeysuckle order. It grows wild in the woods of some parts of England. Its stem attains a height of about 8 feet; its bark is whitish, and renders it a desirable member of a shrubbery in winter; its leaves are opposite, oblong-ovate, and downy; its flowers grow from the sides of the branches, have a white or yellowish-white colour, and bloom in June and July; and its fruit are red berries, and ripen in September.

FLY. A dipterous or two-winged insect. The word, in popular usage, is sometimes so restricted as to designate only a few species or at most a limited portion of the dipterous order, and sometimes so extended as to include some winged insects of other orders; but it best comports with definiteness of idea, and at the same time is not much twisted out of any of its ordinary applications, when used as strictly synonymous with the scientific name diptera.

The wings of flies, or of dipterous insects, are two in number, and consist of veined and transparent membranes, and are attached to the middle of the sides of the thorax, and, for the most part, possess, near the point of their insertion, a pair of short clubbed organs called halteres or balancers. The body consists of head, thorax, and abdomen. The mouth has a sucker of from two to six lancet-like scales, enclosed in a kind of sheath. The antennæ exceedingly vary in several of their characters, but especially in their length. The eyes are lateral; but, in some instances, they meet on the summit; and in others, they are so large as to occupy nearly the whole head. The legs, in most species, are long and slender; but in some, are thick and spiny,—

and in others, are exceedingly long.—The larvæ of flies have a fleshy head and a simple structure; and in general are so like one another that those of different species or even of different genera are quite undistinguishable from one another by unpractised observers. Most of the larvæ pass into the pupa state without shedding the skin, or simply by a gradual transmutation of it into a cocoon; and some shed the skin and become inert-looking and cocoonless pupæ; but two entire families of flies, the hippoboscidæ and the nycteribüdæ, possess the extraordinary constitutional habit of producing their young in the condition of pupæ, or of effecting the transformations from ovules to larvæ and from larvæ to pupæ within the body of the parent.

Flies, as to both their numbers and their habits, act a powerful part in the economy of the animal creation; and, in not a few instances of great moment, challenge the attention of almost all observers, but particularly of cultivators of the soil. "In their perfect state," to adopt the comprehensive and beautiful statement of Mr. Westwood, "they are scarcely less numerous, in point of species, than any other order of insects; but if we look at them with respect to the number of individuals, we find them infinitely to exceed any other. The clouds of midges, *Chironomus*, for instance, rising at eventide over the marshes, like the incense of the Temple, equally pay homage to the Divinity, in showing forth his mighty power; whilst myriads of flies of every kind are to be found in every quarter of the globe, traversing plants and every animate object, and more particularly all that has ceased to live. This immense profusion with which they are dispersed over the globe, causes them to fulfil two very important functions in the economy of nature;—first, they serve for food to a vast number of the higher animals; charged with a divine mission by Him 'who giveth food to the young bird,' the swallow and the sparrow destroy them by myriads, and the flycatcher and the humming-bird alike find in them a constant shedding of manna;—whilst, in the second place, they cease not in effecting the disappearance of all substances in a state of decomposition, both animal and vegetable; they are universal scavengers, and so great is their activity, and the rapid succession of their generations, that Linnæus might well say that three flies can consume a horse as fast as a lion. Amongst such a vast number of objects, it is not surprising that some should be found obnoxious to ourselves or our properties. Many species, accordingly, cease not to make man their prey, by sucking his blood, whilst some either attack our cattle in like manner, or deposit their eggs upon their bodies, within which the parasitic larvæ feed; others deposit their eggs, or young, upon our growing corn, and upon our prepared food of various kinds. Many species reside in woods, in meadows, marshes, and in our habitations; others move with dancing feet upon the spray of the waves, and even upon the snows of the polar regions. Many are attached to plants, upon the flowers of which they abound, sucking the honeyed sweets, without giving the preference to any particular plant, whilst some are confined to a single species of flower; but it is upon the star-like anthemis of our meadows, that the majority seem to revel with the greatest delight. During the summer and autumn, the flies are attracted to our orchards, in order to destroy our fruits, whilst some species delight in the honey-dew of the aphides, or the fluids which escape from the wounds of trees. The domestic fly feeds alike upon all kinds of household provisions; and other species, which so closely resemble it in size and appearance as to deceive an ordinary observer, are parasitic upon the nests of various solitary bees. Nothing, indeed, can be more amusing than to watch one of the latter following the laborious insect, the young of which she is about to supplant by her own, peering about into the mouth of the nest, and cautiously making her entrance, in order to deposit her own eggs, when the bee has, with great toil, completed her nest, and deposited her store of honey-paste for the food of her own progeny."

FLY-IN-SHEEP. A disease in sheep occasioned by the larvæ of several species of flies. This disease must not be confounded with mere uneasiness from the attacks of various small diptera, nor even with the painful and serious affection which results from the presence of the larvæ of the gad-fly. See the article BOTS. Fly-in-sheep, as a distinctive disease, is frequently known also under the name of maggot-in-sheep, or Scoticé mawk-in-sheep; and is always occasioned by larvæ belonging to the genus musca or flesh-fly.

All the species of muscæ closely resemble one another in both appearance and habit; and at least four of them, *M. vomitoria*, *M. carnaria*, *M. cadaverina*, and *M. Ceasar*, are concerned with the disease in sheep. M. vomitoria is the common flesh-fly or blue-bottle, and has a black or dark-blue thorax, and a dark glossy blue abdomen; M. carnaria is the grey flesh-fly, and has a grey thorax, with three black longitudinal markings on the upper surface, and a grey abdomen somewhat chequered, and appearing in some positions of a shining whitishness; M. cadaverina has a shining bluish thorax, and a shining green abdomen; and M. Ceasar shares with the preceding the name of green flesh-fly, and has also a shining green abdomen. M. vomitoria and M. carnaria usually appear in April, and the other two species in June; all are exceedingly active during the warm weather, flying nimbly and vigorously about in search of their food, and depositing on it their viviparous ovules; and they continue to be more or less active and alert till they are killed or sent into hybernation by the effects of the commencing frosts of winter. They profusely exist in all parts of the globe where they can be fed on putrefying matter, and are particularly abundant in beef-eating Britain; and so enormously do they multiply, that one female has been ascertained to give birth to 20,000 young. But the larvæ are vastly mightier scavengers and devourers than the perfect insects, and have been known to devour so much food and to grow with so great rapidity as to increase their weight two-hundred-fold in twenty-four hours; and they feed alike upon putrid parts of living quadrupeds, upon dead carcases, and upon all kinds of animal or putrescent filth. They are produced alive in hot weather; and if they have plenty of food, they usually attain their full size in five days after being hatched; and they then cease to eat, and crawl two or three inches under ground in order to be transmuted into pupæ; and after about a fortnight, the pupæ crack their shells, and the perfect insects appear.

The fly deposits its ovules on sheep from May till September, but particularly in hot showery weather, and very specially in August and the early part of September. The green species are usually the earliest depositors; and sometimes one species is abundant while another species is rare,—and the blue bottle, in particular, may be very common, while the grey flesh-fly may be little known. The ovules are most commonly placed underneath or round the tail, and sometimes upon the back; and the larvæ creep in among the wool, and prey upon the skin and flesh. As soon as the larvæ begin to eat, the wool at the place appears wet and dirty; after it proceeds with gnawing the flesh, a putrid smell is emitted, and invites other flies to make their deposits; and so rapidly does the work of destruction progress, that in twenty-four hours the injury may be irremediable, and in forty-eight hours the sheep may die.

In 1828, on five farms adjacent to Loch Lomond and Loch Venachoir, in spite of sedulous efforts to prevent mischief, 195 sheep out of a total number of 4,090 died from the attacks of the fly, and 355 more were attacked and, in many instances, were long in recovering. A sheep, on being attacked, ceases to feed, exhibits great uneasiness, rubs itself against rocks and trees, or bites itself and tears off the wool; and it runs violently about the field in a manner indicative of great pain and the utmost impatience,—or it walks or trots away from the flock, as if seeking shelter from the heat of the sun, and continues to move about till exhausted by suffering or fatigue,—or it runs into the shade and seclusion of a deep ditch or some similar place, and there lies writhing in torture, till it is discovered by the shepherd or dies.

One occasion of the attacks of the fly is a little purging or diarrhœa, and a consequent dirtiness about the tail of the sheep; another occasion is neglected wounds or sores of any kind about the back; another, is a foul state and consequent rank smell of the wool; and a fourth, probably far more powerful in some localities than all the other three, is the allowing of carcases or pieces of dead sheep to putrefy on the surface of the ground, and so both affording a burrow for a prodigious multiplication of the fly, and giving the insect a taste or inclination for the peculiar food of sheep's flesh. Yet the main cause is either unknown or as yet uncontrollable by man; and preventives and remedies must be used with reference simply to the four occasions which we have stated, and to the appearances which accompany and follow the actual deposition of the ovules.

Appearances of diarrhœa ought to be promptly observed and corrected; wounds and sores ought to be promptly and regularly dressed; pieces of clotted or foul wool ought to be cut away and buried; the general cleanliness of the flock ought to be thoroughly and constantly maintained; and all pieces of animal matter which have belonged to sheep ought to be so disposed of as not to become niduses for larvæ. During the heat of the day, the flock may be kept in the highest and airiest situations of the pasture, away from close heat and from the fly-frequented vicinity of woods, thickets, and hedges. On farms where muscæ threaten to appear in great multitudes, or at times when they seem about to make prodigious increase, a carcase of some kind may be exposed in a corner of the pasture, or on a waste spot in its immediate vicinity, as a lure for them to lay upon; and the larvæ produced upon it may, on every third or fourth day, be washed out and drowned. Whale oil or any tar which has a strongly empyreumatic smell may be rubbed over the parts of the sheep most likely to be attacked, or may be streaked simply upon their horns, ears, or tail; or pulverized quicklime may be dusted over the parts.

When attacks actually begin, a careful and judicious shepherd may effect more good by forethought and vigilance than even by medicinal applications. "Too much attention," says Mr. Cleeve, "cannot be bestowed on the flock by the shepherd to discover the affected sheep; for although the discoloration of their wool, and the uneasiness which the animal manifests on most occasions, might seem enough to attract attention for the most superficial examination, I am persuaded by experience that, without the strictest scrutiny, many of the flies will be passed over, the coat become injured, and not unfrequently the sheep destroyed, before it has been discovered that it is seriously ill. The flock should be separately examined, one by one, before the flies are busy; and, during the day, it should be carefully noticed whether flies are inclined to settle on any particular sheep; and if so, on close inspection of that sheep, it will be found that there are fly-blows or maggots, even although the animal at the time seems insensible of it."

An efficient and very common application, immediately after sheep have been fly-struck, is white lead; and this, if applied beforehand, will act also as a preventive. A preparation recommended by Mr. Spooner as more effectual than simple white lead, consists of 4 ounces of white lead, 1 ounce of white arsenic, 6 ounces of sulphur, and 2 ounces of cinnabar of antimony, all finely pulverized, and well mixed together; and a preparation successfully used upon the flocks belonging to the Earl of Leicester, consists of 1½ ounce of arsenic, 1 gallon of water, 3 ounces of soap, and 2 ounces of tobacco, the arsenic boiled in a bag in the water and stirred during the boiling, the tobacco boiled in the same manner, and the whole mixture boiled up with the sliced soap for half-an-hour, and 1½ pint of it applied to each sheep. But arsenic is far too mighty an ingredient for such common use, and vastly too active a poison to be kept upon a farm and passed through the hands of shepherds; and when used in any such manner as in these preparations, it may now and then be found to perpetrate enormously more evil than can possibly result from the fly. A safer preparation, and quite as effective an one, even when the skin is much broken by the maggot, consists of one pound of quicksilver and half-a-pound of venice turpentine, rubbed together unintermittedly or for about 8 or 9 hours in a marble or wedgewood mortar till they are thoroughly incorporated, and then fused up, over a slow fire, with half-a-pound of resin and 5½ pounds of hog's lard. This ointment should be applied immediately to the skin, in furrows of the wool, a little beyond the affected parts; the wool should then be rubbed or rolled up and down with the fingers, in order that the maggots may be touched with the ointment and fall out; and a second and final application of the ointment ought, in the course of a few hours, to be made to any spots which were overlooked or still continue to be affected. In very bad cases, when the sores are too numerous and pervading to admit of the use of the ointment, the parts affected ought to be cleared of the wool, bathed with milk, slightly dusted with white lead, and very softly brushed with linseed oil; and this treatment, followed by the use of a constant covering for keeping away the flies, ought to be daily repeated till the maggots completely disappear.—*Q. Journal of Agriculture.—Transactions of the Highland Society.—Cleeve's Prize Essay on the Diseases of Sheep in Journal of the R. Agricultural Society of England.—Kirby and Spence's Entomology.—Spooner on the History and Diseases of Sheep.—Clater's Cattle Doctor.—Hogg's Shepherd's Guide.*

FLY-IN-TURNIPS. See Turnip-Fly.

FLY-IN-WHEAT. See Wheat-Fly.

FLYCATCHER,—scientifically *Muscicapa*. A genus of birds containing the type of the family Muscicapidæ. The birds of this family belong to the dentirostral order, and are very closely allied to the todies; and they have a depressed beak and somewhat rounded wings. All the smaller species are literally flycatchers and flyeaters, sweeping down upon insects from branches or other posts of observation, capturing their prey upon the wing, and then wheeling suddenly back to the spot whence they descended.—The common spotted flycatcher, *Muscicapa grisola*, is the type of the whole family. Its length is fully 5½ inches; its wing-coverts and the upper part of its body have a hair brown colour; the lower part of its body is white; its breast and the crown of its head have spots of a darker colour than the wing-coverts; and its legs and feet are black. Its eggs have a white ground, tinged with blue and spotted with pale orange-brown. Its nest is built on beams, broken walls, branches of wall-trees, the lower boughs or gnarled branches of solitary forest-trees, and in similar situations. It abounds on the Continent, as far north as to the verge of the arctic regions; and it arrives in Britain in May, and departs toward the end of September or early in October. It frequents pleasure-grounds, orchards, and gardens; and is accused by many orchardists and gardeners of eating cherries and other fruit; but it really feeds altogether upon soft insects, and ought to be regarded as the friend and not the foe of the cultivator.—The pied flycatcher, *Muscicapa luctuosa*, has been thought by some naturalists to be a native British bird, but it is only a summer visitor, and comparatively rare.

FLYING. The progressive motion of a bird, or other winged animal, in the air. Flying and swimming are leaps taking place in fluids, and the motion is produced by the resistance which the fluid makes to the surface of the wings or fins, when moved by the animal with great rapidity. The velocity with which the wings or fins must be used, depends on the rarity of the medium in which they move. It is less in water, greater in air near the earth's surface, and increases as the animal ascends into the higher regions of the atmosphere. Birds cannot therefore fly above a certain height, dependent on the strength of their muscles; and they are capable of rising to a greater height when the barometer is high than when it is low. The muscles moving the wings and fins, but especially the former, require a force vastly superior to that necessary to produce a simple leap upon a firm surface. As a flying or swimming body is entirely surrounded by the medium in which it is placed, it experiences an equal resistance in front as well as from behind on striking the fluid. An animal would be incapable of advancing, if it did not possess the power of greatly diminishing the surface of its wing or fin, immediately after having struck the fluid.

Flying and swimming are sometimes performed by the same animal; but the former is executed most perfectly by birds, and the latter by fishes. Some birds never fly. The ostriches, auks, and penguins, are possessed of small rudimental wings, but they seem to have them but for the purpose of conforming more nearly in external resemblance to other birds. Some mammalia can fly, although they have no wings. The bats possess a membraneous expansion, extending to the feet and to both sides of the tail, but supported chiefly by the humerus, the fore-arm, and the four fingers. These bones being greatly elongated, serve to support the membraneous surface, which is of firmness and extent sufficient to raise and maintain these animals in the air, when acted upon by the powerful muscles of the breast.

The first motion of a bird in attempting to fly is an ordinary leap with the feet. Accordingly, those birds having the wings very large and the feet very short—as we observe in the booby and the martens—commence their flight with great difficulty, as they cannot leap sufficiently high to obtain the space necessary for the extension of their wings. In flying, the resistance of the air is in proportion to the mass struck at one time. On this account the short-winged birds must repeat their vibrations very frequently; they are therefore soon fatigued, and unable to continue their flight for a long time. When a bird attempts to fly, the humerus is first elevated, and then the entire wing, which had hitherto remained folded; while, at the same time, it is extended in a horizontal direction by means of the fore-arm and the last division of the wing, corresponding to the foot of quadrupeds. After the wing has thus acquired all the superficial extent which it is capable of attaining, the bird suddenly depresses it, until it forms an acute angle with the vertical plane of the body, subtending the ground. The air resists this motion, which is performed with great rapidity, and produces a reaction of part of the force upon the body of the bird. Its centre of gravity then rises in the same manner as in other leaps. The wings may be compared to a lever, of which the pectoral muscles are the moving power, and the body of the bird the weight; while the air resisting, by its inertia, the action of the expanded wing, is the fulcrum. The impulse being once given, the bird refolds the wings by bending their joints, elevates them again, and gives a new stroke to the air. The force of gravitation diminishes the velocity which the body thus acquires in ascending, in the same manner as it affects every other projectile. There consequently occurs a moment in which the bird neither ascends nor descends. If it seize this moment precisely, and give a new stroke to the air, its body will acquire a new velocity, which will carry it as far as that obtained by the first impulse; it will then rise in a continuous manner, and with a uniform velocity. If the second impulse of the wing commence before the impulse arising from the first has been lost, the bird will ascend with an accelerated motion; or, if the bird do not vibrate its wings at the exact moment when the ascending velocity is lost, it will begin to descend with great rapidity. Yet the bird may keep itself always at the same height by a series of equal vibrations, if a point be seized in the fall so situate that the velocity which would have been acquired in descending, and the small space there would have been to reascend, reciprocally compensate and destroy each other; but if it once allow itself to descend to the point from which it departed, it can only rise by a much stronger exertion of the wings. In descending, the bird has only to repeat less frequently the vibrations of its wings. The *darting* of birds of prey is occasioned by their suppressing the vibrations of the wings altogether, when the bird, being continually acted upon by the force of gravity, falls with an accelerated velocity. When a bird in descending suddenly, breaks its fall, it is called a *recover*. The resistance of the air then increases in proportion to the square of the velocity, and the bird rises again.

The preceding remarks apply only to flight when made in a vertical direction, either in ascending or descending. The quails, larks, and other birds which are observed to fly upwards in a straight line, have the wings placed entirely horizontal; but in the greater number of birds the wing is inclined, and turned backwards. This inclination may be further increased at the will of the bird. It is greatly assisted by the length of the quills, which enable the resistance of the air to act on their extremities with a mechanical advantage, while they are the more elevated by it, from their fixed points being placed at the base. By this arrangement, birds are enabled to advance in a horizontal, as well as in a vertical direction, by a series of oblique curves. The oblique motion upwards in flight may be resolved into two other motions, the one in a horizontal direction, independent of the force of gravity, and the other in a vertical direction, opposite to that power. In flying horizontally, the bird rises in an oblique direction, and does not make a second movement of the wings until it is on the point of descending below the line of the intended direction of its flight. These partial movements, therefore, will not take place in a straight line, but in a series of curves, nearly approaching to the straight line, and in which the horizontal motion greatly prevails over the vertical. In ascending obliquely, the wings move with greater rapidity; in descending obliquely, their vibrations are less frequent; and both of these motions are performed by a series of curves. Some birds cannot sufficiently diminish the obliquity of their wings, and with them the horizontal motion is always very considerable. When the wind blows strongly in the same direction with the flight of these birds, they are carried to a very considerable distance out of their intended path. For this reason, those birds of prey which the falconers term *noble*, are under the necessity of flying against the wind when they wish to rise perpendicularly upwards. The anterior quills of their wings being extremely long, and their extremities pressing closely upon each other, the horizontal motion with them is proportionally greater than that of other birds. On the contrary, with the *ignoble* birds the quills of the wings are separated at their extremities, and permit the air to pass between them, which renders the wing less capable of assuming the oblique position. Deviations from the rectilineal path to the right and left, are chiefly occasioned by the unequal vibrations of the wings. When the left wing vibrates the more frequently, or with the greater force, the left side moves more rapidly, and the body necessarily turns to the right. The rapid movement or greater force of the right wing produces a corresponding turn to the left. The difficulty of suddenly turning increases with the velocity of flight; and this arises partly from the inertia of the body, which perseveres in its rectilineal course, and partly from the increased difficulty of making the one wing to surpass the other in its velocity. For this reason, birds of rapid flight make great circuits in turning. Some will turn on the side, and make use of the tail as a rudder, when they wish to change the horizontal direction.

The tail of birds, when expanded, serves to sustain the hinder part of their body. When depressed during flight, the resistance of the air forms an obstacle which raises the hinder part of the body and depresses the anterior; upon turning the tail upwards, a contrary effect is produced.

As all birds do not fly, so all fishes do not swim, yet there are many birds which perform two motions, resembling those more particularly belonging to each class. Aquatic birds are improperly said to *swim;* and the poet, describing the swan "sailing with the breeze," is perhaps not aware that his term is philosophically correct. The bodies of aquatic birds are naturally lighter than water, from the great quantity of air which they contain within the abdomen, and from the feathers, which are oily and impervious to moisture. They precisely resemble a boat, and have no further occasion for the feet than as oars for moving forwards. As the fore part of the body is completely sustained by the water, the legs are situate farther backwards than those of other birds, that their effect may be more direct, as their presence farther in advance would be superfluous. The legs and thighs are short, that the resistance of the water to the muscles may be as slight as possible. The tarsus, or instep, is compressed for cutting the water, while the toes are very much expanded, or even united by a membrane, in order to form an oar of greater breadth, and capable of acting upon a greater surface of water; and when the bird inflects its foot in order to give a new stroke to the water, it closes the toes upon each other to diminish the resistance of the fluid. In diving, these birds are obliged to compress the breast with much force, in order to expel the air which it contains. The neck is then elongated, that the body may acquire an inclination forwards, while, by striking the feet upwards, it is forced downwards. The swan, and some other aquatic birds, spread their wings to the wind, and use them as sails to diminish the labour of paddling.

FLY-WHEELS. The simplest of all contrivances for regulating machinery are fly-wheels, which are nothing more than large heavy wheels driven with great velocity by the machinery to which they are attached. When a fly-wheel is put in motion, it derives a very high momentum from its weight and velocity, and may therefore be regarded as a sort of reservoir of power by which the machine is supplied with velocity whenever there is any defalcation in the moving power, any intervals of rest arising from the nature of the machinery, or any inequality of resistance arising from the nature of the work to be performed. In the single steam engine, for example, while the piston is descending, and when no impelling power is exerted, the momentum of the fly keeps up the rotatory motion of the machinery till the impelling force is again exerted during the ascent of the piston. In Vaubone's pile-engine, when the resistance is suddenly removed, the horses are prevented from falling solely by the momentum of a heavy fly-wheel, against which their force is exerted till the ram or weight is again raised. Fly-wheels are sometimes made with vanes which regulate the descent of a weight by the increased resistance of the air; but they are not much used in machinery. The fly-wheel is best made of cast iron, and should be of a circular form that it may not meet with much resistance from the air. Many have supposed this wheel to be an increaser of power, whereas it is, in reality, a considerable destroyer of it, as appears evident when we consider that it has no motion of its own, but receives all its motion from the first mover; and as the friction of the gudgeons and the resistance of the air are to be overcome, this cannot be done without the loss of some power. Yet this wheel is of great use in many cases, namely:

1st. For regulating the power where it is irregularly applied, such as the treadle and crank moved by the foot or hand; as in spinning-wheels, turning-lathes, and flax-mills; or where steam is applied, by a crank, to produce a circular motion.

2d. Where the resistance is irregular, or by jerks, as in saw-mills, forges, slitting-mills, powder-mills, &c., the fly-wheel, by its inertia, regulates the motion; because, if it be very heavy, it will require a great many little shocks or impulses of power to give it a considerable velocity; and it will, of course, require as many equal shocks to resist or destroy the velocity it has acquired.

While a rolling or slitting-mill is running empty, the force of the water is employed in generating momentum in the fly-wheel; which force accumulated in the fly, will be sufficient to continue the motion without much abatement, while the sheet of metal is running between the rollers. Whereas, had the force of the water been lost while the mill was empty, its motion might be destroyed before the metal passed through the rollers. Where water is scarce, its effects may be so far aided by a fly-wheel as to overcome a resistance to which the direct force of the water is unequal, that is, where the power is required at intervals only. A heavy water-wheel frequently produces all the effect of a fly-wheel, in addition to its direct office.

FOAL. A young horse. It naturally suckles between nine and ten months; but among the Arabs, it is never allowed to suckle longer than one month; and in good management among British farmers, it is usually allowed to suckle about five months, or not more than six. The Arabs, during about 100 days after the weaning of a foal, feed it solely with camel's milk; they next, during about another hundred days, give a little water-soaked wheat along with the camel's milk, and eventually allow the animal to eat some pickings of grass and drink a little water; and they then, for some time longer, increase the quantity of milk, and give either barley or dates and water. A foal, under British treatment, and especially upon British farms, ought to be very early accustomed to feed partially on corn, and to acquire the elements of the habits which it is expected to possess in its maturity. When its dam is used for the plough or the cart, and is economically sent to her work as early as her strength will bear, the foal ought for a time to be left in the stable during the hours of work; but as soon as it is able to keep up with her slow pace in the yoke, it ought to be allowed to accompany her, and to walk by her side; for it will then get milk oftener, and become hardier in constitution and more tractable in disposition and more precocious in the instincts of a domesticated horse, than if it continued to spend all its time in the stable or in the paddock. During three or four weeks after weaning, it ought to be housed or turned into a rick-yard, or kept in a paddock with warm sheds and a low rack and manger; and during the whole period of its rearing, but especially during the period succeeding the weaning, it ought to be abundantly and most nutritiously but not delicately fed. Bruised oats and cut hay may now be liberally given; meal or almost any other farinaceous food is excellent; oats in the straw may be acceptable if thrashed oats should seem to be disrelished; and carrots may act well, both as a part of diet immediately after weaning, and as a corrective of excessive dryness in the other food or of costiveness in the bowels. The subsequent treatment of the animal falls to be discussed in the article HORSE.

FOALING. See PARTURITION and ABORTION.

FOAL-TEETH. See AGE OF ANIMALS.

FODDER. The bulky vegetable food of the domestic animals, and particularly of cattle. It does not properly include any kinds of food which contain nutritious matters in a concentrated form, such as corn, pulse, or roots; but it includes all bulky kinds of food, whether green or dry, which either act principally as ballast or possess the properties of both ballast and nourishment,—such as the culms of the cereal grasses, the stems and tops of the forage grasses, the haulm of leguminous plants, and the entire herbage of meadow-grasses, clovers, lucern, sainfoin, melilot, tares, vetches, and bird's-foot trefoil.

The qualities of almost any one kind of fodder, whether green or dry, widely vary with differences of soil, climate, weather, and culture. Any green food produced on any spot in a dry season is much more nourishing than the same weight of the same food produced on the same spot in a dripping season, and any herbage or hay-provender raised on a rich dry soil is more nourishing than the same thing raised on a poor wet soil. So very various is the quality of hay, that 100 lbs. of the best upland meadow quality, cut as the flower expands, and properly saved and stacked, is as nourishing as 120 lbs. of a second-rate quality, or 140 lbs. of a third-rate quality, or 200 lbs. or even more of the coarsest and hardest quality; and were the highest care exercised in selecting and cultivating the grasses of a primely situated and richly alluvial artificial meadow, a hay could probably be produced of at least four times the nutrimental value of the coarsest kinds occasionally used on farms. Straws and haulms, too, are exceedingly controlled in value, both by the specific nature of plants, and by the character of soils and seasons. Straw-fodder of any species from gravelly soils or from strong clay lands, is better than straw-fodder of the same species from cold moorish lands or from deep black loam; and the straw or haulm of any plant cut in a somewhat greenish or succulent state is more nutritious than the straw or haulm of the same plant cut in a thoroughly ripened state. The haulm of pease is better than the straw of oats; and either of these is exceedingly better than the straw of wheat, of rye, or of barley.

But the relative nutritiousness of different kinds of fodder, as well as of some of the principle kinds of concentrated alimentary substances, ought to be seen at one view, and has been very happily exhibited by M. Antoine of Nancy in France, upon the authority of experiments by Thaer, Schwertz, Boussingault, Pohl, and about a dozen more of the most distinguished agriculturists of the Continent. One hundred pounds of good upland meadow hay is equal to 102 of lattermath hay, 90 of clover hay made after the blossom is completely developed, 88 of clover hay made before the blossom has expanded, 98 of second crop clover hay, 98 of lucern hay, 89 of sainfoin hay, 91 of tare hay, 90 of dried spergula arvensis, 146 of clover hay with the seed in it, 410 of green clover, 457 of green vetches or tares, 275 of green Indian corn, 425 of green spergula, 325 of the stems and leaves of Jerusalem artichoke, 541 of cow-cabbage leaves, 600 of beetroot leaves, 300 of potato haulm, 374 of spelter wheat-straw, 442 of rye-straw, 195 of oat-straw, 153 of pease haulm, 159 of vetch haulm, 140 of bean haulm, 195 of buckwheat-straw, 170 of dried stalks of Jerusalem artichokes, 400 of dried stalks of Indian corn, 250 of millet-straw, 201 of raw potatoes, 175 of boiled potatoes, 220 of white Silesian beet, 339 of mangel-wurzel, 504 of turnips, 276 of carrots, 287 of kohl-rabi, 308 of Swedish turnip bulbs, 350 of Swedish turnips with the leaves on, 54 of rye, 45 of wheat, 54 of barley, 59 of oats, 50 of vetches, 45 of pease, 45 of beans, 64 of buckwheat, 57 of Indian corn, 32 of dried French beans, 47 of chestnuts, 68 of acorns, 50 of horse-chestnut, 62 of sunflower-seed, 69 of linseed-cake, 105 of wheat bran, 109 of rye bran, 167 of oat-chaff or wheat-chaff, 179 of rye-chaff or barley-chaff, 73 of dried lime-tree leaves, 83 of dried oak leaves, and 67 of dried Canada poplar leaves. See the article Food of Animals.

Fodder, however, bears a direct and important relation to farm-yard manure as well as to the feeding of stock. The weight of the excrement of a sheep, an ox, or a horse bears a definite proportion to the weight and quality of his fodder; and the weight of the entire manure obtained may easily be either calculated or predetermined by the allotment of fodder, the allotment of litter, the selection of animals, and the duration of confinement within the house or the yard. Let a man simply reckon how much allotted fodder an animal is allowed in the day, how much litter is laid down to him in the day, what proportion the weight of the fodder bears to the weight of the excrement, and what degree of decomposition is allowed to take place upon the litter and the excrement, or what proportion of loss is occasioned by gaseous dissipation, and he may know to almost the smallest fraction of a pound what quantity of manure will be realized. According to an average of experiments and observations made by Veit and Block, and published by the former, 1 lb. of ordinary meadow hay yields 1¼ lb. of manure from a sheep, 1½ lb. from a horse, and 2 lb. from an ox or a cow; 1 lb. of straw fodder yields 1.2 lb. of manure from a sheep, 1.4 lb. from a horse, and 1.9 lb. from an ox; 1 lb. of green grass or green clover yields 0.37 lb. of manure from a sheep, 0.4 lb. from a horse, and 0.6 lb. from an ox; 1 lb. of potato tubers or of turnip bulbs yields ¼ lb. of manure from a sheep, ½ lb. from a horse, and 0.7 lb. from an ox; 1 lb. of grain yields 1 lb. of manure from a sheep, 1½ lb. from a horse, and 2 lbs. from an ox; and 1 lb. of straw litter yields 1.37 lb. of manure with a sheep, 1.7 lb. with a horse, and 2.2 lb. with an ox. "It is known," adds Veit, "that the dry fodder and the juicy, estimated according to hay value, with litter employed for the cattle, for manure in general, will give double the weight in moderately decomposed manure. For the production of 19,800 cwt. of manure, there are therefore necessary, of materials for the manufacture of manure, 9,900 cwt." He then shows that 50 morgens of potatoes, 20 of winter rape, 20 of winter wheat, 20 of winter rye, 40 of summer rye, 20 of barley, 20 of oats, 20 of pease, 10 of beet, 20 of red clover, 10 of lucern, 60 of thrice-mowed meadow, 117 of twice-mowed meadow, and 90 of once-mowed meadow, may, after deducting the loss of dung on the meadows, be computed to yield 12,147 cwt. of immediate fodder and litter produce, and 24,294 cwt. of manure. Professor Burger says, "The dry nutritious substance, or that which is reckoned by its dry weight, suffers in the bodies of beasts a considerable diminution by the loss of that which the absorbing vessels appropriate to themselves from it, and which, with the excrements secretory of nutritious substances, are so easily decomposed by the process of putrid fermentation, that in a short time its substance, as well as its weight is very considerably diminished. If we therefore say that 100 lbs. of dry substance of consumed fodder, with a proportionate quantity of litter, gives 200 lbs. of manure, this must be understood of stall-manure, where the greatest amount of urine is mixed in part with solid excrements, or if they should be dissipated on the dunghill, would be replaced again by rain. The more raw, more recent, stall manure is, the more the beasts drink, the more they take of juicy food, the greater is the proportion of the weight of stall-manure compared with the weight of the fodder eaten; wherefore there is more manure from horned cattle than from horses, and the least from sheep."

FŒNICULUM. See Fennel.

FŒTUS. The young of a viviparous animal while in the womb, and the young of an oviparous animal while in the egg. The elements composing the bodies of the vertebrated animals are analogous; but the analogy exists most perfectly only up to a certain period of animal development, and this period is not the same in all, but varies according to the degree of complication in their structures. A young unborn mammiferous quadruped resembles a human embryo, which is less grown than itself; but at the same time it resembles the embryo of a bird in a higher state of advancement, that of a reptile in a still more perfect condition, and that of a fish, when completely finished, and perhaps already born. Thus, the classes of vertebrated animals are perfectly analogous only at ages differing for each class. Fishes and reptiles may only resemble birds and mammalia which are much younger than themselves. These last-mentioned animals, on the contrary, continue to grow, and to increase in complication at a period of time long after the reptiles and fishes have ceased to develop themselves. We thus see the cause of the greater complication of structure among the higher animals. They are all identical in their first formation, but the reptiles continue their growth for a longer time than the fishes; the birds longer than both reptiles and fishes; and man and other mammalia longer than these three classes of birds, reptiles, and fishes. Since all the vertebrata can thus be brought to one common type, and to a base nearly identical for all classes, it follows that each higher animal undergoes revolutions analogous to those, observable in the whole series of animals inferior to it. One single vertebrated animal of the highest order, will hence exhibit in those transitory states of existence, which pass from its first origin to its final completion, all those characters which are permanent arrangements in the lower classes of vertebrated animals. It also arises, that the first ages of the human embryo form analogous types to the other animals; it first resembles a fish, then successively a reptile, bird, and finally a mammiferous animal. Hence it appears, that in studying the development of the human embryo, we are reading a minute, and, in its leading characters, an accurate description of the physiology belonging to the higher classes of animated nature. It has been often admired that so small and delicate an organ as the retina of the human eye can exactly represent a distant and intricate scene with a precision which the most perfect human artist would in vain attempt to imitate; and shall we not equally admire that minute and exquisite disposition of things, by which the most complicated characters belonging to the distant inhabitants of the sea, of the land, and of the air, are thus brought together and transcribed in miniature, so that a complete history of a large portion of the animal kingdom is traced within the shell of an egg, or the membranes of a human embryo!

This remarkable disposition of Nature requires further elucidation. The skin of the human embryo precisely resembles that of certain reptiles, or even of the medusæ and polypi, by its softness, its perfect nakedness, as well as its simplicity. In the earliest age, the anterior and central opening of the abdomen corresponds to a disposition observable in the oyster and some other mollusca, which have the mantle divided during the whole period of their life. At this time, likewise, the muscles are colourless, soft, gelatinous, and destitute of tendons, as we may see among the lower animals, such as the worms. The bones of the human fœtus are nearly rounded, as we find in adult animals of the lower grades. The same bone which is designed to form afterwards a whole, perfect in itself, is at this early period broken up into as many separate points of ossification as we can find divisions, permanently separate among the mammalia and birds, but especially among the adult reptiles and fishes. This singular correspondence of the temporary state of the human bones with the permanent state of the same bones in the other vertebrata, is particularly observable in the occipital and sphenoid bones, in the upper jaw and temporal bones, in many bones of the face, and also in the sternum, or breast-bone. The breast-bone, for example, consists almost always of nine pieces in the first ages of the human embryo, and nine pieces are to be found in the tortoise during the whole course of its life. The upper jaw-bone is at first composed of five pieces in the human fœtus, and the crocodile continually preserves these five pieces isolated. We might bring forward many other parallel instances of analogy among ages and classes, by entering more minutely into the details of the skeleton. It is only in consequence of this law that the bones of inferior animals are more numerous than those of animals more elevated than themselves, and that the animal skeleton exhibits a greater number of bony pieces, as we approach the first periods of ossification. Indeed, there is almost as much difference between the skeletons of the human fœtus and that of the full-grown man, as between those of the adult reptile and of a mammiferous quadruped in its embryo state.

We shall find that these analogies, between the permanent states of the inferior classes, and the transitory states of embryos of the higher animals, can be traced equally in the heart and circulating organs, in the lungs and respiratory organs, in the nervous system, and in the organs of sense, as well as in the arrangements finally destined to continue the several species. The heart of the human fœtus is first composed of one single cavity. It afterwards divides into four, which form momentarily a communication with each other, but speedily separate, in such a manner that the two cavities of the left side end in having no direct communication with the cavities on the right. This sketch of the progress of the human heart, which is equally applicable to that of the other mammalia and of birds, indicates a new analogy between the very young human embryo, still destitute of a heart, and the worms, which never have a heart. Again, when the heart of the human embryo has only one ventricle, it resembles that of the arachnides and crustacea; afterwards, the heart with two cavities corresponds to those of the fishes and batrachian reptiles. Finally, when there are but three cavities, the two auricles having coalesced into one, it resembles the hearts of the tortoises and serpents; and when the partition of the auricles is pierced by the hole termed the *foramen ovale*, the heart of the human fœtus bears a striking analogy to a permanent arrangement found in the seals.

In following out this comparison of the progress of the human embryo, with the permanent arrangement of the adult animals, we see the venous blood of the human fœtus communicate primitively with the arterial blood, which is a natural arrangement in all the inferior animals, beginning from the birds. The digestive canal is at first short and simple, as we find in animals of the lowest degree. The liver is originally composed of little compartments, as may be seen continually in the crustacea; afterwards, it resembles that of the mollusca, in being formed of lobes slightly united. The spleen and thymus gland are always absent among the invertebrated animals, and the latter is wanting even in the fishes. These organs are developed very late in the embryo of man and other mammalia. The same remark applies to the breast-bone. It is wanting in many reptiles and in all the fishes, and it is very late in making its appearance in the embryo of the larger animals. In general, we find that those organs, of which the lower animals are altogether destitute, are the slowest in being developed in the human fœtus. On the contrary, the greater number of the organs which exist only temporarily in the human fœtus are the first to appear; and thus the gills, which in our species appear, in its very earliest state, soon vanish; and that kind of tail, which may be seen in the human embryo when forty days old, does not exist longer than the fiftieth day. The kidneys of the fœtus among the mammalia are always very large, which arrangement is found to remain continually with the fishes. They are at first lobed and of an unequal surface in the human embryo, nearly resembling that form which may be seen in the adult fishes, birds, and in many reptiles and mammalia. The subrenal capsules are at first very large in the human embryo, a disposition which exists in the apes, and in several adult rodentia, such as the squirrel and mouse. There appears also to exist a *cloaca* in the embryo of man and of the mammalia, as may be invariably found during the whole lives of the oviparous animals, and in the monotremata of M. Geoffroy-Saint-Hilaire.

We see corresponding analogies in the instruments of respiration, and in the manner in which this function is performed. The birds commence by breathing through means of the membraneous filaments of the allantois, just as the polypi respire through the skin. The fœtus of man, at first, has gills resembling those of the fishes; and the batrachian reptiles, before they have lungs fit for acting, breathe through gills like the crustacea; birds breathe through simple membranes before they respire through lungs; and man receives, through the placenta, blood already purified, as long as his lungs cannot gain access to the air of the atmosphere. There are even some animals, such as certain reptiles during their metamorphoses, which successively present all these different modes of respiration, and which thus resemble in turn all the different classes of animals, excepting the insects, breathing through tracheæ. These reptiles respire, at first, through a naked skin like the polypi; afterwards, through external gills, like the crustacea and annelides; after that again, through internal gills, like the fishes; and finally, through lungs, in the same manner as the other animals of their own and superior classes. But these analogies among the transitory states of the fœtus and the permanent forms of the lower animals, when in a state of perfection, are in no respect more evident than in the details of the nervous system. Thus the human fœtus, which we have selected as forming the standard of comparison, has at first certain parts of the brain (*corpora quadrigemina*) exactly similar to those belonging to the perfect reptiles and fishes. These organs were originally hollow, lobed, not quadruple, but double only, and placed merely on the surface of the enkephalon; yet they finally assume the permanent form of the reptiles and fishes. The mammalia are the only animals in which these tubercles become quadruple, and they are the only ones where they become solidified by the obliteration of the central cavity. Besides the above-mentioned analogy in regard to the nervous system, the human embryo presents many other peculiarities corresponding to those of the lower animals. For example, the hemispheres of the brain are possessed at first of only a small volume, and they are rounded in a manner resembling the adult fishes. Certain parts of its brain (*corpora callosa*) are so divided that they appear at first sight to be absent, in the same manner as with the birds of every age. The spinal marrow of the human embryo exhibits a central cavity; and a similar arrangement is found in all perfect animals of classes inferior to the mammalia, while even the lateral nervous cords are originally so much isolated, as to give to the entire structure the appearance which it always preserves in the articulated animals. Besides this, the marrow of the human embryo originally occupies the entire length of the vertebral canal, as in the other animals, but it is only in the third month that it ascends as high as the loins. Finally, its entire nervous system exhibits several analogies to the permanent dispositions in the other classes of vertebrata, such as analogies of consistency, volume, greater or less numerous subdivisions, and even of faculties.

In regard to the organs of sense, analogies of a similar order may be traced. The mouth of the human fœtus is at first without lips, as in the vertebrated animals of the inferior classes. Its palate is then divided, and the mouth, on that account, communicates directly with the nasal fossæ, as in the reptiles and birds. The tongue is originally small as we find in the fishes. The nose and ear present no external projection, in which respect they again resemble these organs in the cetacea, and in the great oviparous animals. Again, the eye appears at first without an eyelid, as it is always found in insects, the crustacea, the mollusca, the fishes, and certain reptiles.

Finally, the general form of the human embryo does not exhibit a less degree of analogy with the perfect states of other animals. The head is at first so slightly developed, as to give to the body of the embryo the appearance of an invertebrated animal. It resembles a fish or a reptile by the absence of the limbs; and the caudal or tail-like appendage, which we have already mentioned, gives it for a short time the aspect of an ordinary quadruped.

From what has been said, it appears that the embryos of the higher animals exhibit in the course of their growth the greater part of the characteristic peculiarities of all classes of animals, and present the fleeting models of almost all the different kinds of organization. The rudiments of man thus form a reduced, yet striking image of the entire animal kingdom. We must admit, however, that these resemblances which have just been enumerated are far from establishing among all beings a perfect and absolute identity, whether we consider different animals in their states of perfection, or upon comparing one animal at the different ages of its progress, and with other animals of different yet inferior species. Every animal preserves continually, and throughout every age, certain well-marked characters peculiar to its species. These differences are so striking, even in those which appear to resemble each other most nearly, that it becomes impossible for us to conclude, that they may all be arranged in one graduated scale, everywhere complete and continuous; or that they all possess one common frame-work, one visible and identical basis, with the same number of essential organs, possessing the same natural characters. Still less can they be supposed to be derived by gradual metamorphoses and complications from one common stock, from binary, or even from ternary types. These analogies being always partial, and frequently vague, can by no means warrant the adoption either of the universal chain of existence proposed by Bonnet, or the transmutation of species, and the successive filiation of Demaillet and Lamarck. Still less will they admit the adoption of the organic identity proposed by certain French and German writers. If animals resemble each other universally, it is only in the great phenomena of existence, of which we have already treated. When, however, we descend to the instruments producing these phenomena, we are surprised to find the most striking difference, instead of resemblance, which can be considered as perfect. One animal seemingly superior to another in some of its organs, is often evidently inferior to the same animal in other details of its structure. We sometimes find that two animals which resemble each other entirely in respect to one set of organs, are sometimes so dissimilar in their conformation, that it is impossible to blend them together even in imagination. Finally, there are some organs of which certain entire classes of animals are altogether deprived, and yet they may exhibit, in two other classes of animals apparently allied to each other, the most discordant characters. Indeed, it is certain that there is not a single organ which does not vary from one genus or from one family to another; but at the same time; there is not an organ, except perhaps the stomach, which can be found in all families and in all genera.

The real cause of analogies among different ages and species must be found in this,—that they are all constructed upon models evidently analogous. The same Divine Artificer formed them all. We find the same style in every page of the great book of Nature; and we everywhere see the most evident affinities both in the essential organs of animals, and in the phenomena which they exhibit.

From what has already been said, we may easily perceive the cause of those wonderful productions, those *Lusus Naturæ*, or monstrous births, which in all ages have astonished and alarmed the ignorant. These evidently arise from a retardation in the growth of some organs. An animal, though remaining incomplete in regard to one organ, may yet continue to grow in all other respects, and the disproportion of the organs may thus proceed to the most shocking disparity. Another consequence of this law is, that the abortive and imperfect organs of an animal must resemble the usual organs of the same animal in an earlier state of its existence, or those of a lower animal in an adult form. Though all the organs may have been originally perfect, yet if one ceases to develop itself, while all the others continue their progress, the monstrosity of the final result is the necessary consequence. It follows also, that what is a deformity in one animal, may be a constant and permanent character of another. The monstrosity of a higher animal may bear a decided analogy to the regular form of one of another grade. For example, it is evident that one of the mammalia, born without hair, is analogous to the lowest classes of animals having the skin naked. If the skin be scaly, it brings the quadrupeds down to the level of the fishes and the ophidian reptiles. The mammalia and man often have a divided palate, like the birds, the fishes, and many reptiles. The occasional absence of the teeth in mammalia may be explained on the same principle. The monstrous development of the liver is found naturally in birds, fishes, and also in some cetacea and reptiles. To want the tongue, or to have it forked—to have the limbs abortive, or altogether wanting, though monstrous developments, are natural and constant arrangements in other species. The following are the most remarkable of the laws of monstrosity, or, as Lord Bacon calls them, "the laws which govern the sports of Nature:"—

1. Monstrosities are always found more frequently in females than in males. The cause of this is to be found in the fact, that the male sex is a more advanced state of development than the female. All embryos, of whatever sex they may ultimately be, are at one time females. In in-

fancy, too, the female character predominates. Young boys preserve for many years the smooth chin, the narrow larynx, the silver voice, and the rounded limbs of the young female. The young birds of both sexes have at first the same plumage as their mothers, and moult at the same time that they do. The same thing holds with all the other characteristics of the male sex. The mane of the lion, the crests, spurs, and other ornaments of the male birds, the antlers of stags, the horns of cattle, the vivid colours and powerful energy which belong to the males of different species, are all characters slow in developing themselves.

2. Monstrosities never exceed certain limits, and deformities have their fixed laws. Thus, when there are supernumerary fingers, they are always similarly disposed.

3. They always preserve a degree of symmetry, even among the most shocking irregularities. A double monster seems to result from the same law, which occasions both sides of the body to be symmetrical.

4. The absence or excessive smallness of one organ is always followed by the extreme development of another.

5. Monstrosities are more frequently found in the left side than in the right, because the left side is always the more feeble and imperfect.

6. Deformities generally go together in pairs. Thus, the presence of supernumerary fingers and the division of the palate; the excessive smallness of the lungs, with a great development of the liver; and these dispositions, which usually coexist in monsters, are found naturally in many animals.

7. The most diversified organs of the animal series are the most liable to monstrosity in the higher animals.

8. Monsters always have some of their organs below their age, and consequently below their class, but never above them. A monstrous bird or quadruped often has its organs analogous to those of a reptile or of a fish; a fish or reptile never has those of a bird. This rule is general and constant.—*Cuvier.*

FOG. There is a constant ascent of watery particles from the surface of the earth, occasioned by the evaporation from masses of water and moist bodies. Part of the water which rises in vapour is intimately united with the atmospheric air, which holds it in solution. This portion of aqueous matter is invisible, and exists in the greatest quantity in very warm and serene weather. Thus, in the hot days of summer, any cold body (as a vessel filled with iced water) is immediately covered with little globules of water, which are the vapour of the atmosphere precipitated. But when the air is saturated, the watery particles which continue to rise are no longer dissolved, but remain suspended in vesicular vapours, which form clouds (q.v.) when they rise to a great height, and fogs when they hover near the surface of the earth. Fogs are more frequent in those seasons of the year when there is a considerable difference of temperature in the different parts of the day; as, for instance, in autumn, when, in the warmest part of the day, the air is capable of holding a great quantity of aqueous matter in solution, which, on cooling, towards evening, it is no longer capable of dissolving. In hot weather, the air is not so easily saturated, and in cold weather, the process of evaporation is very slow, so that, in these cases, fogs are less common. In low, moist places, and in confined places, as valleys, forests, bays, or lakes, surrounded by high lands, they are much more prevalent than in open countries, or elevated spots, where they are quickly dispersed by the winds. There is another atmospherical phenomenon, which has been called *dry fogs.* In 1783, all Europe was enveloped with a dry fog, at the moment of a simultaneous volcanic action in Iceland and Calabria. In 1755, before the earthquake which destroyed Lisbon, a similar fog overspread the Tyrol and Switzerland. It appeared to be composed of earthy particles reduced to an extreme degree of fineness. See the articles EVAPORATION, ATMOSPHERE, HOAR-FROST, and DRAINING.

FOG, or FOGGE. Sphagnum or any number of green moss-plants; also, winter verdure; also, the grass which appears after the removal of the hay-crop. But all these three uses of the word are provincial.

FOGGING. See AFTERGRASS.

FOISSEN, or FUZZION. The natural juice of grass or other succulent herbage. A foissenless substance is any piece of provender almost destitute of juice,—dry, hard, wiry, and insipid. But both the noun and the adjective are provincial.

FOLD. An enclosure for sheep. The fold in use among the ancient eastern nations, and alluded to in the Sacred Scriptures, was an enclosure of masonry, provided with a strong door for ingress and egress, and designed, among other purposes, for the protection of the sheep from the attacks of wolves and bandits. A stell or sheep-stell, in use upon some of the large sheep-farms of Britain, is merely a place of temporary refuge from any sudden storm of spring or autumn, and especially from sudden or severe snow-storms of winter. See the article SHEEP-STELL. A standing-fold or fixed fold, in use upon many farms, is an enclosure for feeding sheep upon carried food, littering them, and collecting their manure. It may be erected either on any dry piece of pasture land or immediately adjacent to the farm-yard; and in the latter case, it may have part of the farm-buildings for one of its sides, and may derive from it the advantages of shelter. The grand use of it is to collect manure; and the manner of constructing it needs to have reference only to the confining of the sheep within its limits. A sheep-cote may differ from a standing-fold merely in being close and strong and high enough to afford shelter from severe weather; or it may contain such provisions for the niceties of feeding, the facilities of collecting manure, and the maintenance of pure air and a comfortable temperature, as shall render it the same thing for sheep which the courts and the sheds of the farm-yard are for cattle. A moveable fold is a temporary enclosure, commonly in a quadrangular form, with wooden hurdles, with iron hurdles, with wire hurdles, or with nets suspended upon ropes, and stretched between posts or attached to spikes fastened in the ground; it is proportioned in size to the number of sheep confined within it, and to the quantity of manure intended to be laid on; it is removed daily or at other stated intervals, in such a manner that its hither side before removal becomes its further side after removal; and it is employed variously for the separating of ewes and their lambs from the rest of the flock,—for combining the winter-feeding of sheep with the manuring of the land by the eating off of turnips,—for the manuring of corn-stubbles or spring-fallows, in preparation for turnips,—for the combined manuring and consolidation of light arenaceous soils,—for the manuring of clover leys, or the manuring, consolidating, and working of naked fallows, in preparation for wheat,—and sometimes, for the burying or poaching-down of the seeds of newly-sown wheat, or the eating down of excessively luxuriant wheat in spring.

Folding in stells—if a temporary retreat within these places can deserve the name—is an affair of mere shelter, and must be regarded as excellent or even necessary provision in all situations in which the sheep are sufficiently hardy in all ordinary seasons, but not hardy enough to pass unscathed beneath occasional extraordinary storms. Sheep-cotes, in so far as they differ from standing-folds by being places of shelter and warmth, may be requisite in preference to stells in some very bleak and exposed situations, or desirable in places too cold and churlish for the selected breed of sheep; but, in general, they foster or induce tenderness of habit, occasion more injury from heat than would be endured in the open air from cold, and restrain the sheep from indulging in their natural and healthful freedom of exercise, and are therefore of very questionable advantageousness or more than doubtful character.

Standing-folds and such sheds and sheep-cotes as but slightly possess a sheltering structure, are highly advantageous, in a few places in Britain, and in multitudes of places on the Continent, for the collecting of manure. The floor is either spread with argillaceous sand, calcareous sand, or some other clean, dry, and partially alkaline earth, or littered with straw, haulm, stubble or dry leaves; and the consequent manure obtained is as regular in accumulation, and as easily collected, as that of the courts and sheds of the farm yard. The Annals of Agriculture record an instance of 28 large loads of rich manure having been obtained in six weeks from a standing-fold of eight score of sheep, littered weekly with a load of straw, and supplied twice-a-day with drawn turnips; and the writer of the Treatise on British Husbandry, speaking on the authority of the Hertfordshire Report, says, "In Hertfordshire also, 300 short-woolled sheep, penned in like manner from the end of October to the end of March, and littered with stubble, are stated to have produced 80 cart loads of the richest dung. The plan is, indeed, in use among many persons who have large flocks upon light land, and is there employed for the purposes both of fatting wethers for the market and of procuring shelter for the ewes at lambing time. Mr. Ellman of Glynde, has, for instance, two or three yards with sheds twelve feet wide around them, which, being also littered, are extremely warm, and preserve many lambs in stormy weather. They may be fenced with wattled hurdle-work, for the sake of coolness, lest a greater degree of closeness might render the yard too hot; and the system has answered so well on several large farms, that the sheep are said to have been found more healthy than when kept out on the fields in the common manner."

The use of moveable folds for eating off turnips, or preparing stubble-lands or clover-leys for other crops, is now so established a practice of rotational husbandry as to be almost beyond the reach of question. See the articles Sheep and Turnips. But the use of these folds upon bare fallows, or for the mere manuring of ploughed lands, or in any manner which alternates open depasturing during the day with folding during the night, is an exceedingly doubtful practice, and has for many years been denounced, with increasing earnestness, by the great majority of both scientific agriculturists and well-informed practical farmers. As much as possibly can be said in its favour, perhaps, is succinctly and pithily said as follows in the Survey of Somersetshire: "In a rich fertile country, where the quantity of arable land is small, and in mere subserviency to the grazing system, where dung is plenty, and can be put in the corn-land at a small expense, and where each sheep is highly fed, it is not to be wondered that the folding system should be held in derision and contempt; but I will be bold enough to repeat, that in a poor, exposed, and extensive corn-farm, the soil of which is light and stony, it is the *sine qua non* of good husbandry. Let me ask its opponents whether the downs of Wilts and Dorset would wave with luxuriant corn if folding were abolished? No. The farmer would plough and sow to little purpose, were his fallows to remain untrod with the feet, and unmanured by the dung and perspiration of these useful animals. Besides, in the hot summer months, nothing is so grateful to the flock itself as fresh ploughed ground; and sheep will, of their own accord, retire to it when their hunger is satisfied." But the practice of folding on naked fallows fatigues and injures some breeds of sheep by the daily travelling, disturbs the digestion of all by preventing them from resting where they have fed, retards the fattening of all by keeping them throughout the night without food, damages the wool of all by its contacts with the soil both in travelling and within the fold, poaches any clay lands or strong loams which the flock traverse in passing between the fold and the pasture, and impoverishes the pasture-land in the precise degree in which it enriches the folded land, or transfers the manuring process of the flock from the grass-fields in which they feed by day to the fallow-lands in which they rest by night. Yet wherever the practice is persisted in, it may, in some degree, be palliated by using only store-flocks and hardy short-woolled sheep, by taking care that they have abundance of food on the pasture, and by retaining them in the pasture sufficiently late in the evening, and returning them to it sufficiently early in the morning.

FOLDING. See Fold, Sheep, and Hurdle.

FOLIACEÆ. One of the two great divisions of cellular, cryptogamic, or acotyledonous plants. It comprises the ferns, the horsetails, the mosses, the hepaticæ, the lycopodineæ, and the marsileaceæ; while the other great division, called Aphyllæ, comprises the fungi, the algæ, and the lichens.

FOLIAGE. The collective or aggregate leaves of a tree, a shrub, or an herb. A foliage crop is one whose leaves alone are available, and which requires to be used green, and cannot be made into hay. All the cabbages and borecoles, for example, are foliage crops.

FOLIATION. The natural or vernal developing of the leaves of the plants.

FOMENTATION. A warm wash, either of simple or of medicated water, applied by means of flannels to some wounded, bruised, sprained, or swollen part of an animal. Its power as a topical application is great, and, if generally understood and judiciously used, might advantageously supersede many of the heating cataplasms and other strange and injurious appliances of popular veterinary practice. But very much of this power depends on the frequent repetition and prolonged application of the warm wash; and nearly all depends upon the absorption of heat from the wash, and scarcely any from the aromatic and anodyne substances with which it is frequently decocted. Medication with poppy-heads, chamomile flowers, bay leaves, marshmallow roots, wormwood, southernwood and other vegetable productions, rarely serves any purpose except to show off the practitioner and mystify the spectators. Yet vinegar, camphor, and some other active ingredients, not commonly thought of, are occasionally useful. The proper heat, in most instances, is about 100° of Fahrenheit, or as much as the animal can bear, without evincing serious pain; and it may, in general, be greatly prolonged by thoroughly wringing the soaked flannel, applying it with all speed, and laying over it a sufficient quantity of flannel or other cloth to retard or prevent radiation.

FONTANESIA. A small genus of plants, of the olive-tree family. The phillyrea-like species, *F. phillyræoides*, is an ornamental deciduous shrub, of 12 or 15 feet in height, carrying yellow flowers in autumn; and it is a native of Syria, and was introduced to Britain in the latter part of last century.

FOOD OF ANIMALS. The particular kind of food which animals receive when domesticated, exercises a most marked influence over their physical and intellectual constitutions; and unquestionably forms one of the most important branches of their management. As the attachment of each species to any particular kind of food is regulated by its internal organization, it will often happen that a description of food which is greedily sought after by one animal is rejected by another, and if taken by the latter may even become poisonous, of which numerous instances are to be found. Animals, when unconfined, have the advantage of removing from place to place, often to very great distances, as well as with great rapidity, and, guided by an unerring instinct, are seldom deceived in the choice of their food. In their domesticated condition, they are, on the contrary, confined within very narrow limits, and, being entirely submitted to the absolute dominion of man, who is not always guided by the views of an enlightened economy, are reduced to the necessity of appeasing their hunger with the food presented to them by his hand. The contrivances of art are often at variance with the instincts of nature, and the most fatal accidents, not always attributed to this cause, are the consequences of a violation of her laws. The character and habitual dispositions of the domestic animals are influenced, in the most direct and well-marked manner, by the general description, and even the particular variety, of their food. An animal feeding solely upon grass, especially when very watery, is usually dull, slow, and possesses but little activity and vigour, although it may obtain a certain degree of *embonpoint;* another feeding on grass nearly ready for cutting, and deprived of its excess of moisture, acquires more force, and a genuine plumpness. If its nature admit of the use of fruit, these qualities become still more apparent, or, if grain be made choice of, its energy is greatly improved. Finally, an animal feeding upon flesh excels the others in its agility, and its animal forces assume the highest degree of energy, or even ferocity. We have frequent instances of the truth of these remarks in all the omnivorous animals, whose characters undergo a considerable metamorphosis, according to the kind of food on which they may happen to be maintained. Let two dogs be made the subject of an experiment, the one being fed constantly on flesh, and the other on bread, and we shall soon be able to distinguish the former by the superiority of its energy, courage, strength, and ferocity. The carnivorous animals are thus more robust and active than the herbivorous, because flesh is more nutritive and sustaining than a vegetable diet.

It has been correctly remarked by Buffon, that the influence of food is greatest, and produces the most sensible effects, upon herbivorous animals. Animals feeding exclusively upon flesh are much less liable to be influenced by their food than by climate, and the several other circumstances, whether favourable or unfavourable, of the situation in which they are placed.

It is chiefly by a proper selection of their food, that we can succeed in rendering animals, when domesticated, more fruitful than they would naturally have been. By the same means, their flesh can also be rendered more tender, savoury, and delicate. It is more especially during the early periods of their youth, that an abundant and well chosen food is deserving of the highest attention, for the slightest negligence in this respect may produce unfavourable consequences upon their general health, whilst, by an opposite course, we may even succeed, to a certain extent, in correcting an original and constitutional weakness, accelerate the period of puberty, or promote their growth as well as strength. It is even possible, by taking advantage of accidental connate varieties, to perpetuate new races of great value, and render them capable of transmitting these properties undiminished in utility to their posterity. These facts are not always attended to by rural economists, nor is a sufficient degree of attention paid to the kind of food given to young animals. This exercises an important influence over their physical and intelligent dispositions, and an undue parsimony in the distribution of their food, or an injudicious choice in its quality, may be regarded as the vice of a false economy, which deteriorates the qualities of the most valuable species or races, either by diminishing their fecundity, or preventing the development of their most valuable qualities. It is an admitted fact, that, in early life, the preponderating function is that of nutrition, while in the adult the reproductive function prevails. Considerable differences in the height and proportions of individuals are induced by the abundance, the nature, and the quality of their food; and it is to a superiority in these respects, that the domestic animals are generally larger and more prolific than the same wild species, which are not so well nourished.

It may be useful to practical economists to know, that, in general, small animals eat more in proportion to their size than large ones; and for the same reason their vital energy is greater. The quantity of food necessary to the maintenance of the domestic animals, is in the direct ratio of the loss of substance which they experience from various causes. For this reason, all those which labour much, and all species naturally exposed to violent exercise, stand in need of food in proportion to the degree in which their muscular strength is exerted. All animals whose movements are slow, and labour light, require but little food, as their loss of force is inconsiderable; and those, again, who pass their winter in a state of torpidity, may remain for a very long time without food, as their loss of strength during this time is still less. An elevated temperature, by diminishing the force of the digestive organs, and by moderating the movements of the body, renders less food necessary than a low temperature. Hence, we may diminish their allowances, with propriety, during the warmest seasons of the year.

It has already been noticed, that the distinction commonly made between herbivorous and carnivorous animals is by no means constant. This fact has been advantageously applied by rural economists in various ways. Thus the young of herbivorous animals, shortly after their birth, are frequently supplied, when very feeble, with fresh eggs. The same nutritious food is likewise given occasionally aux étalons avant la monte, and, it has been stated, with beneficial results; likewise, also, to race-horses, with marked success.

We are assured by M. Yvart that, in Auvergne, fat soups are given to cattle, especially when sick or enfeebled, for the purpose of invigorating them. The same practice is observed in some parts of North America, where the country-people mix, in winter, fat broth with the vegetables given to their cattle, in order to render them more capable of resisting the severity of the weather. These broths have long been considered efficacious by the veterinary practitioners of our own country, in restoring horses which had been enfeebled through long illness. It is said by Peall to be a common practice in some parts of India, to mix animal substances with the grain given to feeble horses, and to boil the mixture into a sort of paste, which soon brings them into good condition, and restores their vigour. Pallas tells us that the Russian boors make use of the dried flesh of the hamster reduced to powder, and mixed with oats; that this occasions their horses to acquire a sudden and extraordinary degree of *embonpoint*. Anderson relates, in his 'History of Iceland,' that the inhabitants feed their horses with dried fishes when the cold is very intense; and that these animals are extremely vigorous, although small. We also know that in the Ferõe Islands, the Orkneys, the Western Islands, and in Norway, where the climate is still very cold, this practice is also adopted; and it is not uncommon even in some very warm countries, as in the kingdom of Maskat, in Arabia Felix, near the Straits of Ormuz, one of the most fertile parts of Arabia. Fish and other animal substances are there given to horses in the cold season, as well as in times of scarcity. The milk of cows, fed in this manner, has a disagreeable flavour, while the flesh of such animals as are killed for the table is not pleasant. In general it acquires the flavour, whether good or bad, of the substances on which the animals had been nourished, and for this purpose, therefore, vegetable substances are always preferable. Thus, the flesh of the carnassiers, whether true carnivora, or merely insectivora, of ant-eaters, &c., is disgusting; and in the same manner, the flesh of birds is always agreeable in proportion as they feed more exclusively upon vegetables. Animal substances being easily susceptible of putrefaction, impart to the flesh of those which are fed upon them an alkaline and ammoniacal odour. The corrupt fish, sometimes given to the domestic animals of the North, contributes greatly to their inferiority; and it is well known that fish in general imparts less muscular vigour and energy than the flesh of quadrupeds.

The habitual use of animal food renders the herbivorous animals less docile, more untractable, and even dangerous in some cases, as many facts have demonstrated. Cases are quoted of horses, fed in this manner, having devoured their own masters. It is not probable that these animals could long exist on such a diet, without inconvenience, from their internal organization being greatly different from that of the carnivorous animals, especially in respect to the ruminants. Still it is abundantly demonstrated, that animal substances can be administered with advantage, especially in cases of scarcity of their ordinary food, or of weakness, whilst the carnivorous animals have an indispensable necessity of living upon flesh, in order to derive a sufficient nourishment, and to maintain that kind of life for which Nature has intended them.

The food given to the domestic animals may either be composed of entire and unprepared substances, such as Nature spontaneously presents, or it may be divided and prepared in various manners; while its good qualities are susceptible of being improved in several ways, according to the object which is had in view. It may consist of plants either green or dried, whole or divided, moist or dry, raw or boiled, fermented or the reverse, sweet or sour, plain or seasoned with different substances; and, according as it is given to them in these different states, the results obtained are very different.

The mechanical division of boiled food, whether green or dried, facilitates the several acts of masticating, swallowing, and also of ruminating when it occurs; hence, by a necessary consequence, their digestion being more perfectly performed, an equal weight of food becomes more profitable, and this mode of preparation should always be adopted, except when the food is consumed on the field. For this purpose several useful instruments have been invented, such as turnip-cutting machines, choppers, mills, and many others more or less ingenious, which divide quickly, economically, and completely, the different kinds of food, whether roots, seeds, or forage. Every farmer who feels any interest in the improvement of his domestic animals, should be provided with one or other of these instruments, and he will not fail, sooner or later, to be completely indemnified for the additional expenses they may occasion.

Green food is in general more profitable to these animals, especially when it is intended to fatten them, than such as is either faded or dry; for, independently of the loss of nutritive principles which it experiences more or less while drying, it is digested more easily, rapidly, and completely, in the former than in the latter case. For the same reasons, food which has been moistened and softened after being dried is usually more profitable than when given under a hard or dry form. Seeds especially, when broken or reduced to flour, or even made into a paste or broth, are more quickly assimilated into the animal substance than when entire. Hence, they are nearly everywhere reduced to a state of minute division before being given to animals in course of fattening, and numerous experiments have clearly established their comparative superiority over those which have not undergone this process.

The boiling of their food, by performing or facilitating its division, is one of the best means known of promoting digestion, and even of increasing the quantity as well as quality of the alimentary substances which undergo this process. This advantageous result appears to originate in part from the circumstance that the molecules of the alimentary substance are separated by the coction which they undergo, and thus present a greater surface to the influence of the gastric juice, and partly from the influence of the water wherein they are immersed, as well as of the high temperature to which they are exposed, augmenting their nutritive powers. The water seems actually to become solid as in the making of bread, by entering into union with them, or by imparting its hydrogen, which afterwards becoming united to carbon, may contribute towards the formation of fat. These facts have been established by a great number of experiments made here and elsewhere, with roots, grains, and even with raw and boiled hay or grass, used for fattening the domestic animals. Potatoes and Jerusalem artichokes, which, in their raw state, are either cared for but little by the cattle, or unprofitable, acquire by boiling new properties which render them extremely advantageous after having undergone this operation. Indeed, the general practice of boiling the food cannot be too strongly recommended, especially when the low price of fuel, and the other circumstances of the locality, allow it to be performed conveniently and economically. It is also proper to administer it to the cattle while still warm, if possible, for the reason that it appears to be more agreeable to them when given in that state, and that it invigorates and refreshes them more quickly than when allowed to cool after boiling. As a confirmation of the correctness of these views, regarding the superiority of boiled over raw food in the fattening of cattle, we have only to consider for a moment what actually takes place every day before our eyes in respect to man. We here see how greatly substances which have been submitted to the action of heat, such as bread, meat, soups, broths, and other articles, surpass those used in their natural state. A small quantity of wheat, maize, barley, or rice, well boiled and eaten warm with a little milk, gains in nutritive matter an immense superiority to the same quantity of these substances, if eaten without this preparation The same remark is applicable to all kinds of grain. See the articles BOILING and STEAMING.

The addition of some coarse provender, such as chopped straw, to boiled roots, is admitted to be advantageous; probably because it renders the mastication of these substances more complete, and serves also as a kind of ballast, which should always bear a certain proportion to the nutriment, properly so called.

Fermentation, which may be regarded as a sort of cooking afforded spontaneously by Nature, adds greatly to the nutritive qualities of the substances which undergo this process. It has long been recommended to allow the barley, intended to fatten cattle, to germinate, and this may be regarded as the first step in the process of fermentation, which the grain undergoes when used for making beer. By this means, the saccharine principle becomes more fully developed, while the food is unquestionably made more digestible and nutritious. Hence cattle-dealers seek with avidity, and employ with great advantage, the residue of breweries, distilleries, and starch manufactories. A part of the grain thus prepared, or its refuse, is used largely for feeding cattle in Belgium, Alsace, and generally in the immediate neighbourhood of all large manufacturing towns. The nutritive properties of the food are further augmented by rendering it sour, or at least, it tends in this state to render the digestive function more energetic. Hence, the farinaceous substances used for food, especially when it is intended to fatten the cattle, are made in a great number of places to undergo the acetous fermentation. Indeed, all the modes of preparation already enumerated are but little useful to animals destined for hard labour. Seasoning renders the food more agreeable to their taste, more digestible, and therefore more profitable. Common salt is probably the most powerful and useful of all substances for this purpose, and hence it is employed almost everywhere with advantage. It sharpens the appetite, excites to drink, facilitates digestion, renders the flesh of animals intended for the table of a superior quality, and either promotes, or supplies the acidity induced by the second stage of fermentation. All mammalia seek salt with as much avidity in their wild state as in that of domestication, and show a degree of pleasure, which is a sure index of its utility when mixed with their food, and of its power of correcting the hurtful qualities of their aliment when it happens by some accident to have become vitiated.

In addition to those precautions, which are essential to the proper selection and preparation of food for the domestic animals, it is of great importance to regulate the rations or quantity of food distributed to them at intervals, in order that they may be rendered as profitable as possible. The quantity of food ought always to be in proportion to their age, state of health, the violence of their exercise, and final destination, always observing, at the same time, the general principle, that the quantity of the food must be more considerable when it is less substantial, as any diminution of its nutritive qualities can only be compensated by a proportional increase of its quantity. It is always impossible to determine, in a fixed and positive manner, how much of each kind of food an animal should consume in a given time, because this depends upon a great number of circumstances relative to its species, its race or breed, the peculiar constitution of the individual, its employment, as well as its age and state of health. The daily allowances further change with the very variable nature of their food, the different ways in which it is administered, the state of the atmosphere, the season of the year, and several other circumstances, all of which should be taken into consideration before we can determine their proper daily rations with any degree of accuracy. Hence result the various and contradictory opinions emitted on the subject by most writers who have attempted to fix quantities. Some have laid down as a principle, that certain domestic animals will daily consume the third part of their weight of watery food, such as turnips, beet-root, or green clover; while others have fixed for the same animals a fourth part of their weight of cabbages, carrots, and parsnips, and a fifth or a sixth of beet-root, potatoes, and Jerusalem artichokes. There must be, however, a great variation according to the different circumstances just enumerated. It appears to us that all these matters should be regulated by particular and individual trials, and be left wholly to experience. This is of more real use than the futile attempts made in most practical books to fix quantities, and which only serve to demonstrate the real ignorance of the persons attempting to enforce them. Physiologists, and all who have studied this matter properly, know very well, that although there are certain well-ascertained general laws which regulate the entire animal economy, each individual possesses a peculiar constitution, or *idiosyncrasy;* which more or less serves to modify these laws. Hence we frequently find a disparity of effects resulting from the same apparent or real cause, and these variations show themselves in the quantity of food which animals consume, as well as on a great many other occasions, the explanation of which can only be obtained on the principles already explained.

Along with the really nutritive food, there must always be mixed a certain quantity of ballast, that is, of some coarse and slightly nutritious food, otherwise the sides of the stomach, as well as the intestines, will not be sufficiently distended and stimulated, so as to perform completely the functions for which Nature intended them. Unless this condition is rigorously attended to, the digestion, elaboration, and assimilation of the nutritive juices, will always be incomplete, even in healthy and well constituted animals. It is therefore a very important error to overload the stomachs of these animals with any very nutritious food unmixed, even when it is exclusively intended to fatten them.

In respect to the distribution of their food, it is only necessary to notice one excellent maxim, *Good food, a little at a time, and often;* they should be allowed to eat quietly and slowly in order that they may digest the largest quantity of food in the shortest possible time. Regular intervals of feeding should be observed, with occasional fasting, which serves to appetize them, and give an impulse to their digestive organs. They should not, however, be allowed to grow impatient, which occasions a loss of animal force and nutrition. Digestion never proceeds rapidly as long as the animal continues eating. It is only when sufficiently filled that the circulation becomes accelarated, the temperature of the body more elevated, and digestion proceeds with its greatest activity. All these phenomena succeed in the course of a few hours, after which the temperature of the body falls, the respiration becomes moderate, and hunger returns. It is only at this time that more food should be given, in small rations at a time; and when treated in this manner, the animal consumes less, and derives more benefit from its food.

To alternate and vary the kind of food used is always necessary, because the continual use of the same aliment does not sharpen the appetite so well as a judicious selection and rotation. A variety of food serves to stimulate the digestive organs, and prevent that disgust which the same diet continued too long always occasions by its uniformity. Care should be taken, in respect to these changes of food, to avoid a sudden alteration of diet, especially from green to dry food, or *vice versa*, for these are always more or less prejudicial. It is also very important not to overload the stomachs of labouring animals, immediately before they set out to their work, as is too frequently done, for this often occasions indigestion, or at least renders it imperfect or laborious. From want of food or other circumstances, these animals are often obliged to submit to a long fast, which they are always better able to endure in proportion as their food has been the more substantial.

There are some domestic animals, such as the camel and the ass, which are remarkable for their frugality, as well as their capacity of remaining long without food. There are also some races of other animals which are equally celebrated for these qualities; and when they do not originate in some constitutional defect, or from ill health, and when it is not effected at the expense of their other useful properties, this forms a powerful inducement for propagating some races in preference to others. The mule is an instance of the above, as well as some of the improved breeds. A quantity of barley, equal to about one feed, is sufficient, according to the report of travellers, for the daily maintenance of an Arabian saddle-horse, after a long journey in the deserts; while a European horse performing the same service would have consumed, in the same time, a much larger quantity of barley, besides a considerable bulk of hay and straw. The remarkable frugality of the former, although doubtless owing to an original constitution improved by habit, is partly due to a difference in the nutritive qualities of the food, as well as to the climate. If animals of the South consume, in general, a smaller quantity of food than those of the North, this is in part due to the circumstance, that the food is much more nutritious in the former than in the latter case, and also that it possesses a greater specific gravity. It may not be improper in this place to notice a remarkable error almost universally adopted in this country, of giving out corn, which is the most substantial part of their food, by *measure* instead of by *weight*, as it has been ascertained by many trials, that the quantity of really nutritive matter may vary in bulk by nearly one-half, according to the quality of the corn. See the article FEEDING OF ANIMALS.

As the most useful and important of our domestic animals are herbivorous, it may be advantageous briefly to notice here the general qualities of the several vegetable substances which usually form the basis of their diet. The substances principally used for this purpose are: 1*st*, grass, either fresh, or under the form of hay; 2*d*, the straw of the cereal plants; 3*d*, leaves or stalks; 4*th*, roots or tubers; 5*th*, seeds, grains, or fruits. Each of these subjects admits of being treated somewhat in detail.

Grass is the most natural food of the herbivorous animals, and is often sufficient to restore feeble animals to a good condition when they have fallen off, upon any other kind of diet. This food is not, however, adapted for hard-working animals. See the articles GRASSES and GRASS-LANDS.

The best kind of green food is fine, substantial, not very watery or faded, and should not have grown in a shady situation; it is usually found upon natural or artificial meadow-land. The natural families of the gramineæ and leguminosæ are the most abundant in important plants. In the former we may notice the meadow-grasses, *Poa;* fescue-grasses, *Festuca;* fox-tail-grasses, *Alopecurus;* oat-grasses, *Avena;* cat's-tail-grasses, *Phleum;* bent-grasses, *Agrostis;* canary-grasses, *Phalaris;* wheat-grasses, *Triticum;* the barleys, *Hordeum;* hair-grasses, *Aira;* soft-grasses, *Hol-*

cus; dog's-tail-grasses, *Cynosurus;* quaking-grasses, *Briza;* millet-grasses, *Milium;* and a few other genera. Of the leguminosæ, the following are the most remarkable:—the medicks or lucerns, *Medicago;* the trefoils, *Trifolium;* saintfoin, *Onobrychis;* the melilots, *Melilotus;* the vetches, *Vicia;* the tares, *Ervum;* the milk-vetches, *Astragalus;* and the bird's-foot-trefoil, *Lotus.* There are some plants, which not only have the property of exciting a more abundant secretion of milk in those females which are fed thereon, but also render it of an excellent quality; such are the roots of the parsnip or carrot, and the stalks of the maize; while others, such as the garlics, *Allium,* actually impart a disagreeable odour, or other unfavourable qualities. Each domestic animal shows a marked predilection in favour of some plants, and either refuses certain others altogether, or feeds upon them only when compelled by a scarcity of food, as Linnæus and several of his followers have long ago remarked. Not only do they derive pleasure from particular parts of certain plants in preference to the remainder, but the different states of vegetation in which each of them is found, as well as the different situations and nature of the soil on which the plants grow, contribute still more strongly in determining their choice. With a very small number of exceptions, we find in general that when plants are in their flowering state, or one which nearly approaches to it, they are most nutritious. At this time, their nutritive particles are diffused abundantly and equally throughout the whole plant, and they hold a middle state between the aqueous condition which is too relaxing, or not sufficiently nutritious, and the ligneous condition, which renders difficult the functions of mastication, deglutition, and digestion. In general, also, medium qualities of the soil, as well as intermediate stations, should be preferred for pasture grounds.

After numerous comparative trials made at Upsal in Sweden upon the common plants of the meadows, fields, and other pasture lands, it was found, by M. Hesselgreen, that the plants used by each species of domestic animals vary greatly in number. His results are represented in the following table:—

Of 575 plants,	the goat eats	449, and refuses	126
528	the sheep	387,	141
494	the bull	276,	218
474	the horse	262,	212
243	the pig	72,	171

This serves to indicate that the goat is the least delicate in his taste, and can eat without inconvenience a great number of plants hurtful to other species. The sheep feeds upon nearly three-fourths of all the plants it encounters; the oxen and horses refuse nearly one-half, while the hog can eat the leaves and roots comparatively of a very small number of species. The above results are, however, very incomplete, and must be considered merely as approximations.

Subsequently to the investigations of M. Hesselgreen, M. Yvart examined nearly seven hundred of the most common plants of France, or those capable of being naturalized there, and as his inquiry appears to have been conducted with much care, it may be interesting to compare his results with those already given of the Swedish investigator.

	Goat.	*Sheep.*	*Bull.*	*Horse.*	*Hog.*
Can eat . . .	547	408	311	268	86
Is very fond of	28	81	121	113	36
Sometimes eats	32	33	70	39	23
Takes in all	607	522	502	420	145
Refuses . .	83	133	183	235	169
Total plants examined	690	655	685	655	314

Many plants are wholly refused by all animals. Among the principal of these growing in marshy places we may notice the following: The common butterwort, *Pinguicula vulgaris;* common-hooded milfoil, *Utricularia vulgaris;* forget-me-not, *Myosotis palustris;* perfoliate pond-weed, *Potamogeton perfoliatum;* long-leaved cowbane, *Cicuta virosa;* the long-leaved sun-dew, *Drosera longifolia;* the round-leaved sun-dew, *D. rotundifolia;* water-pepper, *Polygonum hydropiper;* sweetflag, *Acorus calamus;* water crowfoot, *Ranunculus aquatilis;* great spearwort, *R. lingua;* and water milfoil, *Myriophyllum spicatum.*

There are several other plants which either grow in somewhat moist pastures or in the shade, and are likewise refused by all cattle. These are the common thorn-apple, *Datura stramonium;* common henbane, *Hyoscyamus niger;* black-berried nightshade, *Solanum nigrum;* dwarf-elder, *Sambucus ebulus;* mountain dryas, *Dryas octopetala;* black horehound, *Ballota nigra;* common white horehound, *Marrubium vulgare;* impatient lady's smock, *Cardamine impatiens;* common celandine, *Chelidonium majus;* and the blue erigeron, *Erigeron acre.* It must be noticed, however, that many of these plants, when very young, are sometimes cropped by the cattle without inconvenience, while some even of the most nutritious plants are refused when in grain, from their perfume being too strongly diffused. After the animals have endured a long continued fast, their discrimination in these respects is not so nice; and the climate may occasion some further differences. Thus, the young sprouts of the wolf's-bane and hemlock become esculent even for man in the North of Europe, where their deleterious properties are not sufficiently developed to become hurtful.

Some plants are often eaten by the cattle while green and fresh, and yet are generally refused by them if offered in a dry or faded state. These are cock's-comb, *Rhinanthus crista-galli;* the horse-tails, *Equisetum;* the bedstraws, *Galium*—which spoil the hay; and the common buckbean, *Menyanthes trifoliata:* while others, such as the crowfoots, *Ranunculus;* and swallow-worts, *Ascle-*

pias, lose their injurious properties when dried, and in that state are eaten by the cattle without inconvenience. Others serve as seasoning, such as the garlics, *Allium*, and the docks, *Rumex*, either of which may be used occasionally as a stimulant or corrective; while the cotton-grasses, *Eriophorum*, and some others, become hurtful from their hairs, which serve as a nucleus to those dangerous ægagropiles or concretions, sometimes found in the first stomach of the domestic ruminants.

There are also a great number of plants eaten without inconvenience by the goat, and even greedily sought after by that animal, while they are refused by all other cattle. The principal are the common mare's-tail, *Hippuris vulgaris;* common prickly-seed, *Echinospermum Lappula;* the greater water plantain, *Alisma plantago*—highly detrimental to all other domestic animals; the wood anemone, *Anemone nemoralis;* that of the meadows, *A. pratensis;* the spring anemone, *A. vernalis;* celery-leaved crowfoot, *Ranunculus sceleratus;* the knotty-rooted figwort, *Scrophularia nodosa;* and tamepoison, *Asclepias vincetoxicum*, of which it is extremely fond. The last mentioned plant can be eaten by the horse, only after it has been killed by the frost. To these we may add, the small water-wort, *Elatine hydropiper;* box-leaved andromeda, *Andromeda calyculata;* biting stonecrop, *Sedum acre;* snapdragon, *Antirrhinum linaria;* stinking camomile, *Anthemis cotula;* black-berried bryony, *Bryonia alba;* marsh lousewort, *Pedicularis palustris;* that of the woods, *P. sylvatica;* hemp agrimony, *Eupatorium cannabinum;* the annual mercury, *Mercurialis annua*, which is poisonous to all other animals, according to Ray and Linnæus; the corn horsetail, *Equisetum arvense;* that of the marshes, *E. palustre;* and the male polypody, *Polypodium filix mas.*

Some plants are eaten solely by the hog, and it is often only their roots that are sought after. The chief of these plants are the common cyclamen, *C. Europæum;* common asarabacca, *Asarum Europæum;* the white water lily, *Nymphæa alba;* and the yellow, *N. lutea*, for which the horse exhibits a marked aversion; the water soldier, *Stratiotes aloides;* sea wrack-grass, *Zostera marina;* and maiden hair, *Asplenium trichomanes.*

A few plants are very much sought after by all cattle, and almost with equal avidity. These are the common millet-grass, *Millium effusum;* meadow soft-grass, *Holcus lanatus;* annual meadow-grass, *Poa annua;* oats, barley, and wheat, the carrot and parsnip, the great round-leaved willow, *Salix caprea;* the Norwegian cinquefoil, *Potentilla Norvegica.* Also, the creeping trefoil, the common lucern, and sainfoin. But many of these plants must be in different states, in order to be liked equally by the several species of cattle.

On considering the entire vegetable kingdom in a general manner, we find that scarcely any acotyledonous plants are fitted for the maintenance of cattle. Indeed, if we exclude the grasses, nearly all of which may be used for this purpose, we find but few even among the monocotyledonous plants. It is unquestionably in the dicotyledonous class that the greatest number of useful materials for this purpose are to be found. The following natural families are arranged according to the order of their utility for food to cattle:—The gramineæ, leguminosæ, cruciferæ, rosaceæ, amentaceæ, umbelliferæ, cucurbitaceæ, and polygoneæ.

The best hay is afforded by the more elevated meadows, and its quality depends greatly upon the care with which it has been dried. In this article quality is much more important than quantity; for a stone of good hay, well selected, and carefully dried, affords more nutriment than several stones of coarse or ill-prepared material,—a matter to which sufficient attention is not always paid. The exposure to the sun or air, during its making into hay, always occasions grass to lose some portion, more or less considerable, of its nutritive substance, which is evaporated along with the watery matter. New hay often occasions indigestion, and it should not be given to cattle for several months after being made, at which time it is entirely deprived of its uncombined aqueous substance. See the article HAY.

Straw should be considered rather as a useful kind of ballast proper to be mixed with the really nutritive food of the domestic animals, than as a substantial nourishment. The best quality is fine, white, short, and massive. It is often advantageous to have it chopped and even moistened. See the articles STRAW and CHAFF.

Dried leaves, as well as the small branches of a great number of trees, shrubs, and bushes, may sometimes form a useful substitute for straw or hay, when the latter cannot be easily procured. The elm, the mulberry tree, the ash, the hornbean, *Carpinus betulus;* the lime trees, *Tilea;* the common maple and sycamore, *Acer;* the common acacia, *Robinia pseudacacia;* the willows, the poplars, the birches, beeches, planetrees, chestnuts, oaks, dogwood, *Cornus;* hazel, *Corylus;* furze, *Ulex;* and the vine, are frequently used for this purpose on the Continent, in places where they happen to be plentiful. See the article FURZE. The same substances, if given in their green state, may also replace the newly-mown grass of the meadows; but they should always be administered with caution, and with a due attention to their effects, which vary according to the species, as well as in their several states of vegetation. The green leaves of a tolerably large number of vegetables are annually cultivated on a large scale, either as food for man or for cattle; such are the leaves of the maize, beet-root, cabbage, carrot, parsnip, potato, and some others, all of which may be used for this purpose in many cases with advantage. See the articles CABBAGE and BEET.

Roots, or rather their tuberous appendages, which are often very large and voluminous, such as those of the parsnip, carrot, beet-root, potato, Jerusalem artichoke, and turnip, are frequently superior to any of the substances already mentioned as a daily article of food for cattle, and many comparative trials have clearly shown that they are in general much more profitable.

Seeds, grains, or fruits, contain, of all the parts of a plant, the largest quantity of nutritive substance under the smallest bulk. They ought to be given judiciously and sparingly to cattle, from their being in general very costly, and there are some other inconveniences to which their frequent use may give rise. Sometimes they are ground, broken, or prepared in different ways in order to render them more digestible and economical. The principal seeds used for the food of the domestic animals are also, in great part, furnished by the useful families of the gramineæ and leguminosæ. Other farinaceous fruits, procured from some of the remaining families, are occasionally added to these; such as the buckwheat, *Polygonum Fagopyrum*, the chestnut, horse-chestnut, and acorn, as well as the oleaginous seeds of cruciferous plants, especially of some varieties of the cabbage, and gold-of-pleasure, *Camelina*. To these may be added, the seeds of flax, hemp, some species of poppy; also beech-nuts and walnuts, or rather their refuse, and some other fruits less common or important. Most of these, however, have the inconvenience of imparting to the flesh of the animals fed thereon an odour and taste by no means agreeable. In respect to the bran or husk of grains, it is nourishing only when it contains some flour mixed therewith, for the outer rind itself is not only destitute of nutriment, but very indigestible, and often injurious. See the separate articles on the several plants which have been mentioned.

FOOD OF PLANTS. The substances, whether gaseous, liquid, or solid, which surrender either all or some of their elements, to be absorbed or imbibed by plants, and converted into their juices, tissues, and secretions. A very large proportion of the elementary matter of these juices, tissues, and secretions consists of carbon; and this is obtained partly from the decomposed humus of the soil, but principally from the carbonic acid of the atmosphere. Another very large proportion consists, though in innumerably diversified degrees and combinations, of oxygen and hydrogen; and this is obtained partly from water, whether liquid or aeriform, and partly from the atmosphere. An exceedingly important proportion, but not a bulky one, consists of nitrogen; and this is obtained partly from decomposing nitrates in the soil, but principally from the ammoniacal products of manures and of dead animal substances, either while these products are in a nascent state, or after they have ascended to the upper atmosphere and been washed back by rains. And a very multifarious and highly valuable proportion, though not a large one, and chiefly identical with the portions of plants which are incinerated or not gaseously dissipated by thorough combustion, consists of alkaline and earthy salts, principally carbonates, sulphates, silicates, phosphates, and oxalates, but with exceedingly varied distribution in both kind and degree among plants of different species and orders; and all the bases as well as some of the acidifying principles of these, are obtained from either the natural matter or the artificial manure of the soil, and are chemically prepared for absorption by the plants, or digested among the interstices and minute cavities of the soil, either by simple solution in water, or by the combined resolving force of water, air, electricity, and other chemical agents. But the question of the food of plants identifies itself, in one view, with that of the composition of plants,—in another, with that of the chemical elaborations of plants,—in another, with that of the vital functions of plants,—in another, with that of the action of manures,—and, more or less, in several others, with the questions of soils, gases, earths, alkalies, acids, and salts; and it may be extensively traced out in many parts of our work, particularly in the articles PLANT, AGRICULTURAL CHEMISTRY, VEGETABLE PHYSIOLOGY, MANURE, FARM-YARD MANURE, AMMONIA, AZOTE, ASHES, ATMOSPHERE, AERATION, DRAINING, SOILS, ALKALIES, EARTHS, CARBONIC ACID, and SALTS.

FOOD-GRASS. See CATABROSA.

FOOL'S PARSLEY,—botanically *Æthusa*. A genus of annual-rooted, white-flowered weeds, of the umbelliferous family. The common species, called also water-parsley, lesser-hemlock, and dog-poison, *Æthusa Cynapium*, grows wild in the waste grounds, corn-fields, and kitchen gardens of Britain. Its root is tapering and whitish; its stem is cylindrical, sometimes purplish, and usually between 12 and 24 inches high; its leaves have a dark green colour, and resemble those of plain parsley, but are fetid; and its flowers have a pearly white colour, and usually bloom from July till September. This plant is poisonous to man, and acts upon him nearly in the same manner as hemlock. It so nearly resembles plain parsley in general appearance, that, for the sake of broad and ready distinction, only the curled varieties of the latter ought to be grown; yet it is readily distinguishable by its having upon each of its involucellums, and close to the circumference of the umbel, three small linear leaves. It is eaten by cattle, and does not seem to do them any harm; it is eaten also by sheep, but does them material injury; and it is eaten likewise by horses, and in small quantities does not hurt them, but in large quantities produces palsy.—Three foreign species, the insipid, the superb, and the cynapium-like, have been introduced to our botanical collections; but, except that the first is very poisonous, they possess very little interest.

FOOT. A measure of length. It is used in many languages, and by most European nations, and seems to have been originally taken from the medium or ordinary length of the human foot; but it has not an uniform length among different people, and is somewhat variously applied. A lineal foot is divided by geometricians into 10 digits, and subdivided into 100 lines; but it is divided for popular use into 12 inches, and subdivided into 144 lines. The foot of Geneva is 19.2 English inches; that of Monaco is about 9.236 English inches; and that of most other places in Europe varies from 11 to 13 English inches. A square foot measures a linear foot along each of the four sides of a surface, and comprises 144 square inches; and a cubic foot measures a square foot on each of the six surfaces of a cubic or solid body, and comprises 1728 cubic inches.

FOOT. The extremity of the limb of any animal which walks. It serves the purposes of both support and locomotion, and has a very widely varied structure in animals of different classes and orders; and, in every instance, it exhibits wonderful and glorious evidences of the wisdom and beneficence of the Creator, and possesses the most minute adaptation to the peculiar habits and condition of each species of animal. A tolerably full view of the anatomy and physiology of the feet of the several domestic animals, would fill a volume; yet a slight and not unsatisfactory idea of them may be suggested by a glance at merely the feet of the horse.

Each foot of a horse consists of hoof and interior,—the former sometimes called the coffin, and the latter generally called the sensible foot. The hoof consists of the wall or crust, the bars, the sole, the frog, and the coronary frog-band. It appears, to a coarse and careless observer, a mere block of horn, for the attachment of a shoe, or the prevention of severe abrasion to the stump; but it really possesses a structure of nice adjustments and close adaptations, and consists of various parts, arranged in mutual subserviency, yet performing distinct functions, and all requiring the attention and care of both the horse-owner and the farrier. The wall is the part visible when the foot stands flat upon the ground,—the bars, the sole, and the frog are upon the under surface of the foot,—and the coronary frog-band is a ribbon-like tissue around the upper rim of the foot, connecting it with the skin; and the wall may be considered as the permanent body of the hoof, while the other parts possess a structure and are capable of changes in peculiar adaptation to the use and habits of the animal. The wall consists of fibres, arranged in a circle and running from the coronet to the base; it constitutes an arch of props for the firm support of the whole limb; and, at the same time, in consequence of its reaction with the other parts of the hoof, it varies in outline with the age of the individual, and eventually acquires the precise form most suited to the uses of the adult. In foals and young colts, it is contracted and inferiorly narrow; but, in after age, it gradually expands and develops till it combines a sufficiency of base with a maximum of mingled resistance and flexibility. "In this, indeed, as in all that relates to the mechanism of the foot," remarks Professor Dick, "the Author of Nature has displayed such an admirable arrangement and distribution of parts, as to excite our wonder and admiration. A wide extended cone of horn might have afforded a sufficient base upon which the limb might have rested; but it would have admitted of but a very imperfect performance of the other functions of the parts. And, accordingly, as it becomes necessary that the foot should be guarded against concussion, and at the same time admit of the greatest freedom of motion, we find that, in the first place, the crust, instead of forming a continued circle of horn, becomes suddenly inflected at each heel, and continued inwards to the centre of the foot, forming the bars, and by this angle or sudden turn of the crust at the heels providing a pillar of strength, well adapted to support the weight thrown on the posterior parts of the foot. The space left free by this arrangement, being filled up with the softest and most elastic portion of horn called the frog, allows of the necessary degree of expansion and contraction of the several parts. In the second place, the horn is so distributed as to admit the greatest freedom of motion in the limbs, with the least possible obstruction. In animals destined for speed, the anterior extremities are brought near each other, to give freedom of motion. This being the case, the hoof, if of a perfectly upright conical form, would almost unavoidably strike and injure the opposite leg, as it passes in action; but, to avoid this, the inside quarter becomes perpendicular; and, to give a sufficient degree of security, the outside is extended outwards, by which means the base is sufficiently enlarged."

The wall, as to both its nature and the manner in which it is secreted, is strictly analogous to the claws of birds and the nails of man's fingers and toes. It has a fibrous structure, and is firmly agglutinated by a horny matter, of contemporaneous secretion with the fibres. Its front part is technically called the toe, its side parts the quarters, and its hinder parts the heels; and these vary from one another in both depth and thickness,—the toe being deepest and the heels shallowest,—and the toe having usually a thickness of about five-eighths of an inch, while the inside quarter has frequently a thickness of not more than three-eighths of an inch. A series of horny laminæ, similar in appearance to the under surface of a mushroom, covers all the interior surface of the wall; a series of sensible laminæ covers all the anterior and lateral surfaces of the sensible foot; and these two series are interworked with each other into the firmest possible cohesion; and they so combine resistiveness with elasticity as at once to give sufficient security to the hoof and the whole limb, and to protect the foot against mischievous and violent effects of concussion to which it would otherwise be constantly exposed. All the horny matter of the hoof, whether fibrous or agglutinating, is secreted from innumerable pores or minute orifices, which terminate the arteries at the coronet, and may be seen in any hoof which has been recently separated from the foot; and it seems to be everywhere pervaded by a fine fluid, which prevents brittleness and maintains the requisite degree of elasticity.

The bars are a continuation of the wall, from its heels toward the centre of the foot or toe of the frog; and they constitute two ridges, one on each side of the frog, and serve the purposes of fully expanding the foot, propping the heels, and preventing contraction of the hoof.—The sole, or horny sole, is situated between the bars and the wall and the anterior extremity of the frog, or immediately over the sensible sole; it consists of a different kind of horn from that of the wall, and has a scaly texture, and is sometimes soft and pulverable on its surface; it has, in its healthy state, a concave or scooped outline; and it protects the sensible sole from contusions, and enables the horse to make a free, firm, and steady tread upon the ground.—The frog is lodged between the bars, and has a triangular outline somewhat like that of the head of a dart; and it projects boldly forward to meet the ground, and to support a portion of the weight thrown upon the hinder parts of the foot. A deep furrow extends forward from the back part of the centre of the frog to about its middle; and two other deep furrows extend between it and the bars to its extremity. "On examining the internal parts of the hoof, we perceive that these furrows cause projections inwards, while the external prominent parts are excavated, so that the frog, notwithstanding its strong appearance when viewed externally, is not possessed, in the natural and healthy structure, of a greater proportion of horn than the rest of the foot. The whole under parts of the hoof, in fact, present a series of partially developed folds, which admit of a freedom of expansion and contraction, with little danger of laceration of fibres. These folds, aided by the circumstance of the frog's being the most elastic part of the whole hoof, allow of much freedom, with the slightest possible displacement in the individual parts; and hence the whole structure is admirably adapted to allow expansion, diffuse force, and prevent concussion."—The coronary frog-band is situated along the summit or upper rim of the wall, and connects it with the skin of the limb immediately above; it has a texture similar to that of the frog, and a form similar to that of a narrow and small belt, and thence takes the name of frog-band; it constitutes a thick and special cuticle for protecting the parts below it and shielding the junction of substances so mutually different as horn and flesh; and it exactly resembles, in both structure and use, the small margin of special cuticle round the root of the nails of the human fingers.

The severe and innumerable evils which result from bad methods of shoeing horses, and the constant occurrence of these bad methods from the ignorance of farriers, have rendered our notice of the structure of the hoof considerably longer than would otherwise have been necessary; and both these considerations, and a regard to the many diseases to which the horse's foot is constitutionally subject, require us to take some notice also of the sensible foot. This is so nicely adapted to the cavity of the hoof as completely to fill it, and, though pervaded with a very keen capacity of suffering and injury, it naturally sustains not even the slightest inconvenience from pressure; but when the bars have been destroyed by bad shoeing, or the frog has been deprived of its hard surface for the sake of producing what farriers conceive to be a neat and fashionable appearance, or a shoe of bad construction has been nailed on, or a good shoe has been applied nearly red hot, the hoof contracts, the cavity proper to the sensible foot is diminished, the nerves and blood-vessels are compressed, the circulation of the blood is impeded, and inflammation and lameness may speedily ensue.

The whole laminated or membranous surface of the sensible foot performs the office of secretion; and is supplied with blood by such a peculiar distribution of arteries as retards the local circulation, and allows time for the formation of nascent horn; and the veins which carry back the unexpended portions of the blood run into one another like the cords of a network over the whole extent of the secreting surface, so as to afford prompt and ready channels of escape from every point, and to prevent the possibility of a rupture either from accumulation of the blood or from retarded circulation. The sensible foot possesses also absorbents for the removal of parts which have become weak or decayed, and nerves for constantly supplying it with sensation and energy; and it comprises, in addition, the coffin-bone, the navicular bone, the sensible frog, and ligaments, cartilages, and tendons. The coffin-bone, foot-bone, os pedis, or proper bone of the foot, has already been slightly noticed in the brief article COFFIN-BONE. Its porous structure is traversed by innumerable blood-vessels; its under surface has a chief concavity to correspond with the sole, and a subordinate or hinder one, to afford space for the firm attachment of the flexor tendon; its front and side surfaces are rough, to suit the attachment of the sensible laminæ; and its upper surface is concave above to receive the coronary bone, slopes off behind to articulate with the navicular bone, rises projectingly in front to give insertion to the extensor tendon, and extends on the sides into two wings to give rise to lateral ligaments, and afford space for lateral cartilages. The navicular bone has an outline similar to that of a boat or a weaver's shuttle, and extends between the wings of the coffin-bone, and serves as a pulley to assist the action of the flexor tendon. The sensible frog, with the accompanying cartilages and sensible sole, constitutes the lower part of the sensible foot, and is nicely adapted to all the convexities of the horny frog. "It fills up the space left between each cartilage; or rather, the sensible frog and cartilages appear to run insensibly into each other. The frog, being made up of a mixture of cartilage, ligament, and a peculiar fatty-like substance, all of which are curiously intermixed and blended together, possesses a considerable degree of elasticity, while it is in a great measure destitute of sensation, for the obvious purpose of rendering it an elastic insensible pad for the support of the posterior of the foot, under severe action, and for warding off the shock arising from concussion, by diffusing its force to the elastic lateral cartilages. It defends at the same time, by its elasticity and insensibility, the deeper and more important parts from mechanical injuries, proving, like the horn and hair at the extremity or posterior of the fetlock, a pad of support, consisting of parts well adapted by their insensibility and toughness to resist the injuries to which this part is in many cases exposed. The frog is in fact precisely analogous to the pads we find in the foot of the dog, in the posterior parts of the feet of oxen,—in short, in the posterior resting-place of the feet of all animals; the sensible parts in all being of a similar structure to the sensible frog, 'cartilago-ligamentous fatty substance,'—and if they have not all a horny frog, a thickening and induration of the cuticle, little short of it may be traced in the feet of almost every quadruped."

The view now given of the anatomy of the horse's foot incidentally illustrates the perfect wisdom and the all-pervading care and goodness of the Creator; suggests the great importance of man's attention to the feet of all the domestic animals; evinces the necessity of great skill and caution on the part of all persons who shoe horses; throws valuable light on the origin, nature, and proper treatment of the various diseases to which horses' feet are subject,—particularly contraction of the hoof, founder, canker, corns, sandcracks, thrush, and quittor; and affords a ready explanation of two or three points which we now have briefly to state respecting malformations or undesirable peculiarities in the structure of the feet of some particular horses.

A thin foot is one which has a thin wall; and, though perfectly well-shaped and in all respects pleasing to the eye, it is peculiarly liable to damage from either the attaching of the shoe, travelling on hard ground, excessive drought in summer, or excessive moisture in winter. The bottom of the wall of a thin foot is generally ragged; and, when the shoe is removed, the whole verge is seen to be thin.—A strong foot has the fibres of the hoof very distinct, and somewhat similar in appearance to those of any easily-splitten timber; and, if not kept carefully moist and pliable, it becomes almost as hard as iron, and renders the foot lame and tender without revealing the cause of the lameness; and when hurt to the quick, and locally inflamed, has such an obstruction of humour, as often to cause a very troublesome eruption round the coronet; and is always subject to rents and fissures of the hoof, sometimes so severe as to terminate in the total disruption of the coffin from the sensible foot.—A narrow-heeled foot, in some instances, is tolerably good; but in others, inclines to heat and rottenness, and, when tampered with in the usual manner of many farriers, is almost certain to become hoof-bound.—A fore-foot of perceptibly smaller size than its fellow, may, in the course of time, become feeble and incapable.—A flat foot, shaped like an oyster, has many rings or wrinkles, and probably requires a hollow-shaped shoe, and generally renders the animal unfit for the saddle, and not the fittest possible for the yoke.—A low-heeled foot renders the animal a bad traveller; and a high-heeled foot is subject to unsteadiness of action, to tripping and stumbling, and to sprains in the coffin and pastern joints.—A foot of disproportionately large size, is usually accompanied with slenderness and comparative weakness of limb, and indicates inability for any brisk or vigorous action.—A white foot is popularly regarded as inferior to a foot of any other colour. "Indeed," says Gibson, "when a horse has too many of his feet white, they do not always prove the best; yet I have seen white-footed horses have their feet such as the ablest judges could not find fault with. When a foot is smooth and tough, of a middle size, without wrinkles, neither too hard and brittle nor too soft, and when the heel is firm, open, and no ways spongy or rotten, and the frog horny or dry, and the sole somewhat hollow like the inside of a dish or bowl, whatever be the colour, such a foot will for the most part turn out good, though the dark or black hoof, when it resembles that of deer, is generally the best; and for this reason, those who are the most curious about a horse's feet do not choose such as have much white upon their legs and pasterns, to avoid their having too many white feet."—*Papers by Professor Dick in the Quarterly Journal of Agriculture.—Gibson's Farriery.—White's Veterinary.—Winter's Horse in Health and Disease.—Youatt on the Horse.—Blaine's Veterinary Art.—Clater's Works.*

FOOTPICK. An instrument for raising landfast stones. It operates on the same class of stones as the crow-bar, but lifts them much more easily, and without the trouble of clearing away the incumbent soil. It consists simply of a slightly-curved bar, a cross handle, and a one-sided tread; but the tread is moveable to either side, to suit the convenience of the workman.

FOOTROT. A disease in the feet of sheep. It has long been common among the soft and somewhat tender breeds which graze on low rank pastures, or are shut up during the night in sheds and houses; and about forty years ago, it began to appear among the hardy mountain breeds, and to spread with a rapidity and operate with a virulence which excited great and just alarm in the minds of almost all sheep farmers of both upland and plain. It has at times prevailed to a very destructive extent; it occasionally devastates particular localities and entire districts; and it has been the topic of excessive conflict of opinion, as to at once its causes, its contagiousness or non-contagiousness, its proper treatment, and the means of preventing it. It prevails most in autumn, attacks some breeds more readily than others, and particularly infests soft and wet pastures; and it sometimes attacks only one of the feet, often attacks some of the feet with more virulence than others, and almost always attacks the fore-feet in preference to the hind ones.

Footrot usually begins with a slightly inflammatory soreness between the claws of the sheep's foot, and provokes a spreading and increasing ulceration till the wall is detached and the whole hoof is lost. The animal attacked with it has at first a slight halt, gradually halts more and more, and, in the course of two or three days, assumes a lank appearance, lags behind the flock, lies much, and occasionally seems confused and anxious to find itself alone. The hoof, in many cases, soon swells: and, in the course of from five to ten days, it is denuded of its coat of insensible laminæ, and hangs loose around the exterior of the sensible foot, entirely separated from it except at the coronet; and it is also eaten through by the disease generally at its lower edges, and it then peels off or falls away in fragments, and eventually leaves the sensible envelopement of the bone quite bare. The animal now gathers its food upon its knees, remains all day on one spot, becomes very lean, is unable to protect itself from the flesh-fly, and, in a hot season or in any circumstances favourable to the fly, is speedily overrun with maggots. See the article FLY IN SHEEP. The malady is usually prevented from arriving at this dismal stage by the attention and efforts of the shepherd; but if the animal lose the hoof and escape the fly, it either dies at the approach of winter, or begins to get a new hoof and to reacquire health about Martinmas. "On examining the foot, in the first stage of the disease, the coronary edge, though no external injury can be traced, is sometimes found a little swollen and inflamed. At other times, the hoof is eroded; but whether it be shattered or entire, an intense heat is always perceptible in the foot, with a strong pulsation of the arteries, where they are inserted into the coronary edges of the hoof; and however sound the hoof may appear externally, the connexion between it and the interior of the foot is always dissolved, though the separation is not evident till the hoof is pared away. A peculiar smell is perceptible, especially in the advanced stages, or when the ulcerous part is newly opened; yet, even in the worst cases, a large quantity of ichor is never discharged, there being little more than will wet the finger, and that only when pressed among it."

The remote cause of footrot appears to be the removal of the sheep from the wild and scanty mountain pastures which it naturally frequents, to the rich, soft, and luxuriant pastures of our improved sheep-walks, and especially of our meadows, parks, and arable fields. The animal is constituted, as to both feet and internal organism, for wandering from peak to peak of alpine pastures, browsing along the cliffs and steeps and ledges of lofty mountains, and alternating a descent from peak to plain in the morning with an ascent from plain to peak in the evening; and when it is removed to our cultivated pastures, it luxuriates in abundance, gorges itself with food, rapidly fattens, becomes comparatively plethoric, and exchanges all its natural habits of travelling and agility for acquired habits of stationariness and indolence. Its feet, which were formed for hard ground and much walking, now want the attrition requisite for the continued healthiness of their function, and become overgrown, and peculiarly liable to injury. The hoofs want friction, and become excessively elongated; and the lower extremity of the wall in particular,—the part which is naturally formed to support the weight of the animal, and to endure the greatest share of fatigue,—grows beyond all due bounds, and either overlaps the sole, and serves to retain and accumulate sand and filth, or is broken off in fragments so as to open new pores, or expose some portions of the sensible foot, to the erosion or irritation of the herbage or the inflaming and ulcerating action of particles of earth. Breeds or flocks of sheep which have been quite recently removed from the mountains to the plains are, in consequence, specially liable to footrot; and breeds of any kind are little liable to it in the proportion either of their living in a comparatively wild state upon poor upland pastures, or of their having become so thoroughly naturalized on the rich grass lands of low districts as to have lost nearly all trace of their originally wild condition and habits. A flock of black-faced sheep brought direct from the mountains to a rich park or a luxuriant meadow are pre-eminently subject to the disease; and if a mixed flock of pure black-faced, of a cross between the black-faced and the Cheviot, of pure Cheviot, and of any variety of Leicester be depastured on any ordinary champaign grass lands, the pure black-faced will be found most liable to footrot, next the cross breed, next the Cheviot, and last of all the Leicester.

One immediate cause of footrot,—a cause in necessary connexion with the remote one, yet very various in the media through which it operates,—is any mechanical condition of pasture which encourages undue growth of the hoof, or prevents the due attrition of its extremities. "The finest and richest old pastures and lawns," remarks Professor Dick, "are particularly liable to this disease; soft, marshy, and luxuriant meadows are equally so; and it is also found in light, soft, or sandy districts. In the first of these it is perhaps most prevalent in a moist season, and in the latter in a dry one; in short, it exists to a greater or less extent in every situation which has a tendency to increase the growth of the hoofs without wearing them away, and more especially where they are kept soft by moisture. It is so prevalent in fine lawns and pleasure-grounds, that they are, in many instances, reduced in value to a mere trifle as a pasture for sheep; they are said to be infected with this disease, and having once become so, the vicissitudes of 'seven' seasons are scarcely sufficient to destroy the contagion. A luxuriant herbage on soft pastures is equally subject to it; and in both cases, the disease is increased in a wet season." The hoof, when overgrown, and especially when at the same time kept soft by moisture, splits, breaks, and occasions irritation to the sensitive parts below, exactly in the same manner as the nails of the human fingers; and as it does not, like these, receive any alleviation or cure from paring, it continues to be increasingly torn and tortured till the tissues of its inner coat are ruptured, and the connecting tissues of the sensible foot are inflamed, and footrot has begun.

Another immediate cause is the existence of bents, wiry grasses, or strong slender stems of any kind upon the pastures; for these are drawn through the clefts of the sheep's hoofs when walking, and produce scalding, inflammation, and all the other tendencies to footrot.—Another immediate cause is inattention to casual wounds and bruises in the feet; for even slight injuries may easily be aggravated into footrot on soft or moist meadow pastures, when vastly more serious injuries would rapidly heal upon the dry and congenial pastures of the hills.—Another immediate cause is the abundance of decomposing roots and leaves; for this, in autumn or the beginning of winter, especially on moist pastures or in a wet season, rapidly increases the blanching of the softened hoofs, and accelerates the progress of injury in the horny matter to irritation in the sensible foot.—A predisposing and concurrent cause of so great power as frequently to be mistaken for the sole active cause, is moisture; and this either brings the immediate causes into operation or mightily aggravates their action; and it may, in multitudes of cases, be mainly or wholly prevented by proper draining.

Some writers and the great majority of practical men believe that footrot is often spread among a flock in some degree, and sometimes almost wholly, by the contagion of the acrid or purulent matter dropt upon the pasture from the feet of diseased sheep; and other writers, with a few practical men, regard the alleged contagiousness of footrot as an idle fancy or a mischievous delusion. Youatt, for example, thinks that a disbelief of the contagiousness of the disease, "would more than decimate our flocks in the course of a very few years;" while Mr. Cleeve maintains, in the teeth of all which can be said to the contrary, that "footrot is not very infectious," and Professor Dick, after an elaborate examination of many arguments and alleged facts, exclaims, "Was there ever anything more absurd than the doctrine that this disease is infectious!" To enumerate the principal authorities and arguments on the two sides of the question, could do no good. When pastures are dry, and clothed with sweet and nutritious herbage, and occupied by a race of sheep which have been long accustomed to them, they will seldom if ever be pronounced 'infected' by the advocates of the doctrine of contagion; and when they are wet or wiry, or clothed with a bibulous and spongy herbage, or occupied by flocks with feeding-habits adapted to poor plains or moorish hillocks or half-waste mountains, they will be equally haunted by the footrot whether it be ascribed to contagion or attributed to their own bad properties. The probability is that footrot in certain circumstances is contagious, and in the great majority of circumstances is not so; and the certainty is, that, for all practical purposes, it may either be regarded as contagious or not, provided the pastures and the sheep be properly adapted to each other, and both be maintained in a normally fair condition. The grand policy in reference to the disease is prevention; and this will mainly be effected by having all the naturally wet pastures in a state of thorough drainage, and by never suddenly transferring a flock from a dry pasture to a moist one, from a hard pasture to a soft one, or from a scanty pasture to a luxuriant one.

The principal means of cure, when footrot actually makes its appearance, are paring away the detached hoof, and dressing the surface with muriate of antimony or some other caustic substance. "When a sheep halts," says Mr. Read, "let your attendant cast him; then, if the hoof is too long, pare it on a level with the sole, shorten the toe, and be particular in examining the foot between the claws. If it is swollen, looks red, or has any discharge of bloody serum oozing from any fissure or fissures, let the solution of the bichloride of mercury or hydrochloric acid be well applied to the part by means of a little tow twisted, or a small flat piece of whalebone; and, in this stage of the complaint, one dressing is usually sufficient. There is nothing so much desired by the farmer as an application which will at once put a stop to this complaint. The trouble it would save is incalculable, when we consider the time it takes to dress the feet every day of from 30 to 50 or 100 sheep. If abscesses have formed around the coronet, and burst, they usually have two or three fistulous openings, which, with your silver probe, you will soon discover. Arm the eye of the probe with a little tow dipped in the solution, and draw it through the sinus or sinuses. If they extend into the joint, the same thing must be done. Twice is most commonly sufficient to apply the solution in these cases; and oftentimes, when you attempt to pass the probe the second time, you will not be able, from its being filled with coagulated lymph. If any of the discharge is between the crust, pare the sole, and with a feather or syringe apply it to the part. Fungus is sure to sprout from any part where the sole or crust is lost, and rapidly will it sprout. Agriculturists and shepherds are at a loss in curing these morbid growths, as they resist nearly all the caustic applications in use, both empirical and those contained in the materia medica. Butyr of antimony, quicksilver and aquafortis, and numerous other applications are of no avail, especially if the disease is of long standing. There is but one quick and effectual remedy, that is the hot iron, which will do more good in five minutes than all the caustics in our pharmacy."—*The Veterinarian.—Quarterly Journal of Agriculture.—Transactions of the Highland Society.—Journal of the English Agricultural Society.—Spooner on Sheep.—Clater's Cattle Doctor.—Mackenzie on Sheep.—Blaine's Veterinary.*

FOOT-SCRAPER. A small fixture, at the entrance of vestibule, dwelling-house, conservatory, farm-office, or compartment of the flower-garden, for clearing away earthy matter from the human shoe or boot. Some very simple forms of foot-scrapers are in use for gardens.

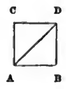
FOOT-TRENCH. A small surface drain, about a foot in width.

FORAGE. The fodder and food of domesticated animals, particularly of horses and cattle. The word forage is used sometimes in the sense of fodder, sometimes in the sense of all bulky food whether of the nature of ballast or of the nature of rich aliment, sometimes in the sense of all herbage or gramineous food, and sometimes in the sense of all vegetable provender whatever, whether eaten as it grows, or cut down and given in the way of soiling, or variously prepared and given in the form of hay or mixtures.

FORCE,—in mechanics. That unknown cause which produces a change in the state of a body, as to motion, rest, pressure, &c.; that is, whatever produces or tends to produce motion, or a change of motion in any body, is called *force*. According to this definition, the muscular power of animals, as likewise pressure, impact, gravity, &c., are considered as forces, or sources of motion, it being evident, from daily experience, that bodies exposed to the free action of any of these are either put into motion, or have their state of motion changed. All forces, however various, are measured by the effects which they produce in like circumstances, whether the effect be creating, accelerating, retarding or deflecting motions; the result of some general and commonly observed force is taken for unity, and with this any others may be compared, and their proportions represented by numbers or lines. Under this point of view they are considered by the mathematician; all else falls within the province of the universal philosopher, or the metaphysician. When we say that a force is represented by a right line, A B, it is to be understood that it would cause a material point, situated at rest in A, to run over the line A B, which is called the direction of the force, so as to arrive at B at the end of a given time, while another force would cause the same point to have moved a greater or less distance from A in the same time. See the figure below.

Mechanical forces may be reduced to two sorts; one of a body at rest, the other of a body in motion. The former is that which we conceive as residing in a body when it is supported by a plane, suspended by a rope, or balanced by the action of a spring, &c., being denominated *pressure, tension, force*, or *vis mortua, solicitatio, conatus movendi*, and which may always be estimated or measured by a weight, viz., the weight that sustains it. See STRENGTH OF MATERIALS. To this class of forces may also be referred centripetal and centrifugal forces, though they reside in a body in motion, because these forces are homogeneous to weights, pressures, or tensions of any kind. The force of a body in motion is a power residing in that body so long as it continues its motion; by means of which, it is able to remove obstacles lying in its way, to lessen, destroy, or overcome the force of any other moving body, which meets it in an opposite direction; or to surmount the largest dead pressure or resistance, as tension, gravity, friction, &c., for some time, but which will be lessened or destroyed by such resistance as lessens or destroys the motion of the body. This is called *vis motrix*, moving force, or motive force, and, by some late writers, *vis viva*, to distinguish it from the *vis mortua*, spoken of before.

Composition of Forces may be thus defined: If two or more forces, differently directed, act upon the same body, at the same time, as the body in question cannot obey them all, it will move in a direction somewhere between them. This is called the *composition* and *resolution* of forces or of motion, and may be illustrated in the following manner: Suppose a body, A, to be acted upon by a force in the direction A B, while, at the same time, it is impelled by another force in the direction A C, it will then move in the direction A D; and if the lines A B, A C, be made of lengths proportionate to the forces, and the lines C D, D B, be drawn parallel to them, so as to complete the parallelogram A B D C, then the line which the body A will describe, will be the diagonal A D; and the length of this line will represent the force with which the body will move. But if the body be impelled by equal forces, acting at right angles to each other, it will move in the diagonal of a



square. Instances in nature, of motion produced by several powers acting at the same time, are innumerable. A ship impelled by the wind and tide is one well known; a paper kite acted upon in one direction by the wind, and in another by the string, is another instance.

Animal Force, as applied to Machinery.—All machines are impelled either by the exertion of animal force or by the application of the powers of nature. The latter comprise the potent elements of water, air and fire. The former is more common, yet so variable as hardly to admit of calculation. It depends not only on the vigour of the individual, but on the different strength of the particular muscles employed. Every animal exertion is attended by fatigue; it soon relaxes, and would speedily produce exhaustion. The most profitable mode of applying the labour of animals, is to vary their muscular action, and revive its tone by short and frequent intervals of repose. The ordinary method of computing the effects of human labour is, from the weight which it is capable of elevating to a certain height, in a given time, the product of these three numbers expressing the absolute quantity of performance. This was reckoned by Daniel Bernoulli and Desaguliers at 2,000,000 lbs. avoirdupois, which a man could raise one foot in a day. But our civil engineers have gone much farther, and are accustomed, in their calculations, to assume, that a labourer will lift 10 lbs. to the height of ten feet every second, and is able to continue such exertion for ten hours each day, thus accumulating the performance of 3,600,000. But this estimate seems to be drawn from the produce of momentary exertions, under the most favourable circumstances; and it therefore greatly exceeds the actual results, as commonly depressed by fatigue, and curtailed by the unavoidable waste of force. Coulomb has furnished the most accurate and varied observations on the measure of human labour. A man will climb a stair, from 70 to 100 feet high, at the rate of 45 feet in a minute. Reckoning his weight at 155 lbs., the animal exertion for one minute is 6,975, and would amount to 4,185,000 if continued for ten hours. But such exercise is too violent to be often repeated in the course of a day. A person may clamber up a rock 500 feet high, by a ladder-stair, in 20 minutes, and, consequently, at the rate of 25 ft. each minute; his efforts are thus already impaired, and the performance reaches only 3,875 in a minute. But, under the incumbrance of a load, the quantity of action is still more remarkably diminished. A porter, weighing 140 lbs., was found willing to climb a stair 40 feet high 266 times in a day; but he could carry up only 66 loads of fire-wood, each of them 163 lbs. weight. In the former case his daily performance was very nearly 1,500,000; while, in the latter, it amounted only to 808,000. The quantity of permanent effect was hence only about 700,000, or scarcely half the labour exerted in mere climbing. In the driving of piles, a load of 42 lbs., called the *ram*, is drawn up 3½ feet high 20 times in a minute; but the work has been considered so fatiguing as to endure only three hours a-day. This gives about 530,000 for the daily performance. Nearly the same result is obtained, by computing the quantity of water which, by means of a double bucket, a man drew up from a well. He lifted 36 lbs. 120 times in a day, from a depth of 120 feet, the total effect being 518,400. A skilful labourer, working in a field with a large hoe, creates an effect equal to 728,000. When the agency of a winch is employed in turning a machine, the performance is still greater, amounting to 845,000. In all these instances, a certain weight is heaved up, but a much smaller effort is sufficient to transport a load horizontally. A man could, in the space of a day, scarcely reach an altitude of two miles by climbing a stair; though he will easily walk over 30 miles on a smooth and level road. But he would, in the same time, carry 130 lbs. only to the fourth part of that distance, or 7½ miles. Assuming his own weight to be 140 lbs., the quantity of horizontal action would amount to 42,768,000, or 28 times the vertical performance; but the share of it in conveying the load is 20,961,780, or about 30 times what was spent in its elevation. The greatest advantage is obtained by reducing the burden to 102 lbs., the length of journey being augmented in a higher ratio. These results are apparently below the average of English labour, which is not only more vigorous, but, in many cases, quite over-strained. Moderate exertion of strength, joined to regularity and perseverance, would be more conducive to robust health, and the comfortable duration of human life. A porter in London is accustomed to carry a burden of 200 lbs. at the rate of three miles an hour. In the same metropolis, a couple of Irish chairmen continue, at the pace of four miles an hour, under a load of 300 lbs. These exertions are greatly inferior, however, to the labour performed by porters in Turkey, the Levant, and generally on the shores of the Mediterranean. At Constantinople, an Albanian porter will carry 800 or 900 lbs. on his back, stooping forward, and assisting his steps by a sort of staff. At Marseilles, four porters commonly carry the immense load of nearly two tons, by means of soft hods passing over their heads, and resting on their shoulders, with the ends of poles, from which the goods are suspended. According to some experiments of the late Mr. Buchanan, the exertions of a man in working a pump, in turning a winch, in ringing a bell, and in rowing a boat, are as the numbers 100, 167, 227, and 248. But those efforts appear to have been continued for no great length of time. The Greek seamen, in the Dardanelles, are esteemed more skilful and vigorous in the act of rowing, than those of any other nation. The Chinese, applying both their hands and their feet, are said to surpass all people in giving impulsion to boats by sculling. The several races of men differ materially in strength, but still greater diversity results from the constitution and habits of the individual. The European and his American descendants are, on the whole, more powerful than the other inhabitants of the globe; and man, reared in civilized society, is a robuster and more vigorous animal than the savage. In the temperate climates, likewise, men are capable of much harder labour than under the influence of a burning sun. Coulomb remarks, that the French soldiers, employed on the fortifications of the Isle of Martinique, became soon exhausted, and were unable to perform half the work executed by them at home. The most violent and toilsome exertion of human labour is performed in Peru, by the carriers, or *cargueros*, who traverse the loftiest mountains, and clamber along the sides of the most tremendous precipices, with travellers seated on chairs strapped to their backs. In this manner, they convey loads of 12, 14, or even 18 stone; and possess such strength and action, as to be able to pursue their painful task eight or nine hours, for several successive days. These men are a vagabond race, consisting mostly of mulattoes, with a mixture of whites, who prefer a life of hardship and vicissitude to that of constant though moderate labour. When a man stands, he pulls with the greatest effect; but his power of traction is much enfeebled by the labour of travelling. If v denote the number of miles which a person walks in an hour, the force which he exerts in dragging forward a load will be expressed nearly by $\frac{1}{5}(12-2v)^2$. Thus, when at rest, he pulls with a force of about 29 lbs. avoirdupois; but if he walks at the rate of two miles an hour, his power of traction is reduced to 14 lbs.; and if he quicken his pace to four miles an hour, he can draw only 3 lbs. There is, consequently, a certain velocity which procures the greatest effect, or when the product of the traction by the velocity becomes a maximum. This takes place when he proceeds at the rate of two miles an hour. The utmost exertion which a man, walking, might continue to make, in drawing up a weight by means of a pulley, would amount, therefore, in a minute, only to 2,430; but if he applied his entire strength, without moving from the spot, he could produce an effect of 3,675. The labour of a horse in a day is commonly reckoned equal to that of five men; but then he works only eight hours, while a man easily continues his exertions for ten hours. See the articles Draught and Animal Power.

FORCEPS. A small hand instrument for lifting, adjusting, compressing, or twisting minute objects. It has a great variety of forms and sizes, and may be made of a considerable variety of materials, and is used in very many useful arts, and in the experimental departments of several sciences. A small forceps is requisite for examining the parts of insects; a platina-pointed steel forceps is requisite in some of the analytic processes of chemistry; and a nicely shaped forceps, with rather sharper teeth than the common kinds of forceps, is now very successfully used for stopping arterial hemorrhage in a horse or ox, by giving the bleeding vessel four or five twists.

FORCING. The accelerating of the growth of garden plants, so as to obtain their flowers, fruit, or other economical or edible produce at an earlier period than they would naturally yield it in the open air. Some plants refuse to be forced, and others are greatly damaged by being forced; but vast numbers of both the most useful and the most beautiful can be forced with more or less facility, without detriment to either the quality of their produce or the vigour of their constitution. But a necessary condition of maintaining full health in even the most easily forced and longest-lived perennial, is to allow it such periods of repose as shall compensate for the periods of its stimulation. Forcing was known among the ancient Romans, and practised from early times in England; and now it constitutes a very large part of the care of all considerable gardeners, whether for floral display, for the private gentleman's table, or for the public vegetable market. The forcing of some kinds of plants, particularly such as require considerable heat but little light, is conducted in pits, sheds, and cellars; the forcing of other kinds, particularly such as are but slightly tender and require blanching, is conducted on hotbeds with various sorts of coverings in the open ground; and the forcing of the great majority, including plants of almost all classes and for almost all purposes, is conducted by means of flues, pipes, or other methods of radiated heat, ranging in degree and kind from the hot-wall of an orchard to the fervent atmosphere of the stove-house. See the articles Hotbed, Hothouse, and Gardening.

FOREHAND. The fore-part of the trunk of the horse, or part immediately before the rider. It has to support and direct the neck and head, and is attached to the former by a great strength and peculiar arrangement of muscles. In a saddle-horse, it should be light and unburdened; but in a draught-horse, it requires a sufficient body of muscle to combine the labour of propelling with that of supporting. "The service derived from extra weight of the forehand, in horses used solely for the draught of heavy burdens, may be thus illustrated:—Suppose a horse endeavouring to make its way up hill overloaded, or as nearly as possible balanced by his load; he uses all his muscular force in vain; he cannot advance, and it is uncertain which will obtain the mastery, he or his load; this is immediately decided by placing a boy or other weight across his shoulders; he is then enabled almost magically to proceed with facility, overcoming his load by means of a few extra pounds on the fore-part of the body." [Winter on the Horse.]

FOREHEAD. The upper part of the front of an animal's head. The forehead of some species of domestic animals has a very different form from that of others; the foreheads of different breeds of the same species considerably vary; and the forehead of a good male of the same breed may be very observably shorter and broader than that of a good female.

FORELEG. See Leg.

FORESTALLING. The buying or bargaining for any corn, cattle, or other merchandise, by the way, before it comes to any market or fair to be sold, or as it comes from beyond the seas, or otherwise, towards any port or creek, to sell the same again at a higher price. At the common law, all endeavours to enhance the price of merchandise, and all practices which have a tendency thereto, whether by spreading false rumours, or by purchasing things in a market before the accustomed hour, or by buying and selling again the same thing in the same market, or by such devices, are criminal, and punishable by fine and imprisonment.

FORESTS. The great importance of wood to society, and the rapid decrease of forests, if particular care is not taken of them, have led, in modern times, to a careful investigation of the subject of the management of forests, and every thing connected with it. The Germans, who first taught mining as a science, were the first who treated scientifically of the management of forests, and established forest academies, in which all branches of the knowledge relating to them are taught. The principal branches taught in them are the following; forest botany, mineralogy, zoology, chemistry; by which the learner is taught the natural history of forests, and the mutual relations, &c., of the different kingdoms of nature. He is also instructed in the care and chase of game, and in the surveying and cultivation of forests so as to understand the mode of raising all kinds of wood, and supplying a new growth as fast as the old is taken away. The pupil is also instructed in the administration of the forest taxes and police, and all that relates to forests considered as a branch of revenue. France has likewise paid attention to her forests, and has enacted a *code forestier*. The English forest laws have reference only to the preservation of game. See the articles Wood, Planting, Coppice, Seed, Nursery, and Game-Laws.

FORGE. A smithy for shoeing horses. Stalls or frames are constructed in the forges of Belgium, for confining the horse within bars, and fastening his foot to a rail, so as both to facilitate the operation of shoeing, and prevent the risk of restiveness and kicking. The shoeing of horses in most of the open forges of Britain is performed in circumstances exceedingly discreditable to the enlightenment of the age, hazardous to the foot of the horse, riskful to the property of his owner, and both perilous to the safety and poorly remunerative to the toil of the operator. "If the horse-shoer blunders," pithily remarks Martin Doyle, "he may lame a horse for months, and cannot remedy the effects of his momentary awkwardness; and yet the most careful and expert smith has no extra allowances for his chances of being kicked to death by a colt unaccustomed to the operation of shoeing." See the article Shoeing of Horses.

FORGE-FURNACE. The forge-furnace consists of a hearth, upon which a fire may be made, and urged by the action of a large pair of double bellows, the nozzle of which is inserted through a wall or parapet constructed for that purpose. Black lead pots, or small furnaces of every desired form, may be placed, as occasions require, upon the hearth; and, the tube of the bellows being inserted into a hole in the bottom of the furnace, it becomes easy to raise the heat to almost any degree required.

FORGET-ME-NOT,—botanically *Myosotis palustris*. A small herbaceous plant, common in wet places throughout all Europe and a great part of North America. The root is perennial; the stem about a foot high, bearing alternate and lanceolate leaves, and small blue flowers, disposed in long, lateral and terminal spikes; the corolla is longer than the calyx, tubular at the base, with a flat border divided into five equal segments; the stamens are five, and the style single; the fruit consists of four naked seeds. It belongs to the natural order *boragineæ*. The brilliancy of the flowers renders them conspicuous, notwithstanding their diminutive size; and it is considered the emblem of friendship among most of the nations of Europe, probably owing to its clear blue, the colour of fidelity. This little flower plays a conspicuous part in albums. See the article Scorpion-Grass.

FORGING. The collisive action and clicking noise of the contact of the hind-feet of a cross-made horse with his fore-feet when trotting.

FORGE-WATER. The water which has frequently cooled hot iron, and has become impregnated with it, in a forge. It was formerly used by farriers as a tonic and a lotion.

FORK. A hand implement with a pronged head and a long wooden shaft. Forks are of various forms, and are used for lifting widely different materials. Forks for taking up loose straw or hay ought to have spindly and long prongs; forks for lifting sheaves, ought to have spindly, pointed, and short prongs; and forks for lifting farm-yard manure or digging up potatoes ought to have flattened, blunted, and somewhat dagger-shaped prongs. The common hay-fork of Scotland is two-pronged, spindle-headed, and long-shafted, and is provincially called "a fow;" and the common manure and potato fork of Scotland has a shaft and cross-handle like those of a spade, and has three flat prongs of about the same compass as the blade or shovel of a spade, and is provincially called "a graip."

FORKEN-ROBIN. An earwig.

FORKING OF SOILS. The stirring and pulverizing of the ground by means of a flat-headed, three-pronged fork. The operation is sometimes performed among growing crops, and is then somewhat akin to hoeing, and produces the threefold effect of destroying weeds, breaking clods, and aerating the soil; it is sometimes performed for loosening and gently upraising young potato-plants, and is then of peculiar character and very doubtful tendency; and it is at other times performed for breaking up very hard or compact garden soil, and is then somewhat akin to digging, or serves as the initiatory process of spade-tillage.

FORMATION (Geological). By this term is meant a mineral bed or stratum, differing essentially from that lying beneath and the one above, both in its aspect, its mineral constituents, and its fossil contents, if any are found in it. In most of the formations there are some mineral and fossil affinities; and in many, even where the external differences are apparently complete, there are some common characters, by the aid of which a passage from one to the other can be traced. Thus the chalk differs essentially, both from the green sand which lies beneath it, and the plastic clay which lies above it, in its aspect, its mineral constituents, and many of its fossil contents. Yet the green sand passes into the chalk marl, and this last into the chalk. Their common characters are almost obvious enough to warrant our classing all the beds of chalk and green sand in one formation, did not the cretaceous and flinty characters of the first distinguish it, in a marked manner, from all the rest. By *formation*, also, is meant an assemblage of beds, distinct from each other, but lying in a group in a determinate order, the whole having a common character or affinity, and being constantly found in a particular part of the geological series, overlying another formation distinct from itself. The oolitic series is an assemblage of this kind, having a common oolitic character, from the lias to the Portland oolite inclusive, notwithstanding the important deposits of Kimmeridge clay, Oxford clay, &c. &c., which occasionally separate the calcareous beds. The coal formation, also, which is a series of alternate beds of coal, slate clay, sandstone and limestone, is illustrative of this kind of formation. Coal, it is true, is occasionally found in the inferior deposits of the mill-stone grit, the carboniferous limestone, &c., and under circumstances that might warrant our classing them all in one group, as has been done with the oolitic series, from the prevalence of the oolitic character; but, as fossil coal is only worked profitably in beds, above the carboniferous limestone, the term *coal formation* is more properly restricted, for the present, to those beds, until a more enlarged experience shall produce a more philosophical arrangement of the whole series. The unvarying succession of formations to each other, in the geological series, has been found to exist in parts of the earth widely separated from each other, and warrants, not only the belief that they have come into their order successively, but that the causes which brought each formation to its place were of one class, whether of igneous or of aqueous origin, and operated simultaneously. Whether we consider the invariable succession, in all the observed parts of our planet, of the gneiss to the granite, the mica to the gneiss, and of the subsequent primitive limestones and slates, or the deposits of the carboniferous limestones—we cannot but look to a contemporaneous and regular succession of causes, for the production of these uniform results. And, although the order and continuity of the series are much interrupted occasionally, it is less difficult to believe, that particular circumstances have interrupted such succession and continuity, than that they have not existed.

FORMICA. See Ant.

FOSSE. A ditch or moat.

FOSSIL MANURES. Any mineral manures which contain organic remains. The phrase is commonly used with special reference to calcareous manures, particularly lime, chalk, gypsum, marl, and calcareous sand; but it ought, in all common sense, to be so extended as very specially to include fossil bones, mineralized phosphates, and all sorts of fossilized animal substances which can be obtained for the fertilizing of the soil. The following important passage in Liebig's Letters on Chemistry refers emphatically to fossil manures:—"If a rich and cheap source of phosphate of lime and the alkaline phosphates were open to England, there can be no question that the import of foreign corn might be atlogether dispensed with for a time. For these materials, England is at present dependent upon foreign countries; and the high price of guano and foreign bone prevents their general application, and in sufficient quantity. Every year the trade in these substances must decrease, or their price will rise as the demand for them increases. To restore the disturbed equilibrium of constitution of the soil, to fertilize her fields, England requires an enormous supply of animal excrements; and it must therefore excite considerable interest to learn that she possesses beneath her soil beds of fossil guano, strata of animal excrements, in a state which will probably allow of their being employed as a manure at a very small expense. The coprolites discovered by Dr. Buckland are these excrements; and it seems extremely probable that in these strata England possesses the means of supplying the place of recent bones, and therefore the principal conditions of improving her agriculture, of restoring and exalting the fertility of her fields. There are beds of coprolites in the neighbourhood of Clifton, extending for miles along the bed of the Severn; and fossil excrements and bones are found at Lyme Regis, near Bath, and at Evesham. The osseous breccia, found in many parts of England, deserves especial attention, as it is highly probable that in a short time it will become an important article of commerce. What a curious and interesting subject of contemplation! In the remains of an extinct animal world, England is to find the means of increasing her wealth in agricultural produce, as she has already found the great support of her manufacturing industry in fossil fuel, the preserved matter of primeval forests, the remains of a vegetable world."

FOSTAL. A way leading from a main road to a large country house.

FOTHERGILLA. A genus of hardy, deciduous, North American, ornamental shrubs, of the witch-hazel tribe. Four species or varieties—for they are regarded as species by some cultivators, and as mere varieties by others—were introduced to Britain about 80 years ago; and all are white-flowered, about 4 or 5 feet high, and closely allied in form of foliage to alders, and in botanical character to the amentaceous trees. They are most easily propagated by layering.

FOUL. See Foul-in-the-Foot.

FOUL-FEEDING. A morbidly voracious and vitiated appetite in any of the domestic animals, but especially in horses. A strong feeding horse has simply a powerful appetite, and eats more than the normal quantity of any ordinary provender; but a foul-feeding horse, besides eating insatiably, often prefers filthy food to clean, sometimes abandons his hay for the sake of his puddled and filthified litter, and not infrequently eats vegetable mould, wet clay, or any kind of nasty weeds and miry herbage out of ditches. The habit of foul-feeding, though not itself a disease, is a decided indication of some serious disease in either the intestines or the stomach, and particularly of inward devastation by intestinal worms, or of such an enlarged and morbid capacity of the stomach as nothing but some heavy or mineral substances can even temporarily satisfy. A foul-feeding horse ought to be well purged, to have a solution of chalk in his drink, to receive abundance of exercise, and to be kept in a perfectly clean stall, with very frequent renewals of fresh and good litter.

FOUL-IN-THE-FOOT. A disease in the feet of cattle. It presents a close resemblance both to footrot in sheep and to mild cases of quittor in horses, but really differs from both. See the articles Footrot and Quittor. M. Favre of Geneva inoculated the feet of sheep with purulent matter from the feet of cattle suffering foul-in-the-foot; but he did not succeed in producing any symptoms similar to those of footrot. Foul-in-the-foot appears to be always occasioned by the neglect and aggravation of wounds and ulcers originating in mechanical injury,—particularly in the insinuating of pieces of slate, stone, or stiff wood between the claws of the hoof, or in the wearing, splitting, or bruising of the horn, and consequent abrasion of the sensible foot, by walking for an undue length of time upon flinty roads or other hard and eroding surfaces. It is sometimes ascribed, indeed, to a moist state of the pastures, and sometimes to contagious action; but moisture merely predisposes to it by softening the hoof and diminishing its power of resisting mechanical injury,—and contagious action can take place only when the disease is carelessly and cruelly allowed to proceed till it makes copious discharges of putrid pus upon the ground, and when the hoofs of some of the sound cattle are so worn or broken as to allow this pus to have access to the absorbents of the foot.

The ulcers of foul-in-the-foot usually occur about the coronet, and extend under the hoof, and cause much inflammatory action, very great pain, and more or less separation of the hoof; but they very generally originate in uneven pressure upon the sole, and rise upward from a crack between the claws, and are principally or wholly confined to one side or claw of the foot. A fetid purulent discharge proceeds from the ulcers; and a sinus may sometimes be discovered by means of the probe to descend from the coronet beneath the hoof. The affected animal is excessively lame, and may possibly suffer such excessive pain as to lose all appetite and become sickly and emaciated.

A common method with cow-doctors is to clean the foot, to rub it backward and forward between the claws with a cart-rope, and to dress it with a little butyr of antimony; but either this treatment or anything similar is both coarse and inhumane. If the disease have a very mild form, or be merely in the initiatory stage, it may be readily cured by cleaning, fomentation, and rest, or also by bleeding from the veins of the coronet; if it have a medium character between mild and virulent, it may be cured by cleaning, by cutting away the loose horn, by destroying any fungous growth, and by applying a little butyr of antimony; and if it have a very bad form, or have been long neglected, or have become very aggravated, it will require to be probed, lanced, or otherwise dealt with according to good surgical practice, and afterwards poulticed twice a-day with linseed-meal, and frequently but lightly touched with butyr of antimony.

FOUMART. The polecat.

FOUNDATIONS. The foundation of every wall or building ought to be depressed or sunk at least a foot or two below the general surface of the land, or much more if the building is large, in order to guard against the effects of frost, and to insure the soil from not being washed away by rains or moved by other causes; and this depth should be increased if the erection is proposed to be made on an eminence. As a general rule, in making foundations for brick or stone walls, the upper vegetable mould, or soft covering soil of the land, should be cut through, and the excavation be carried down until the natural firm soil of the country is reached. Should the subsoil be rock or hard stone, no doubt need be entertained of the goodness of the foundation to bear its load; but the rock or stone ought to be under ground, because if it is exposed laterally to the action of the atmosphere or rains, it may moulder and decay with time. If no rock is met with, but the soil happens to be clay, gravel, or sand, it may in general be trusted, provided it is ground that has not been dug up and moved; for these several soils, at the depth of from two to four feet beneath the vegetable surface mould, will in general be found hard and compact enough to bear almost any load, particularly if the earth pressed upon has no opportunity of moving or escaping laterally. Sand is almost proverbially a bad foundation to build upon; but it is only so when it is not confined, as in an open beach, where it is liable to be washed away, or even drifted by the winds, so that the wall may become undermined. But when sand is met with in the bottom of a foundation trench, in a tolerably dry state, and is to be covered on its upper surface with the intended erection, it may in general be trusted to as safely as soil of a more compact and fixed kind. If, however, sand contains a small portion of loam or clay, and is in the vicinity of a spring, or is otherwise mixed with a considerable quantity of water, it will be semi-fluid, and will possess the property of fluids of giving way to any pressure exerted upon it by rising upwards or expanding laterally, when it is denominated *quicksand*, and of course cannot be trusted as a foundation; and when this occurs, the trench must be dug deeper, and as much of the wet sand as possible being taken out by a swinging scoop or other means, its place must be supplied by hard stones or rubble-work, or even by driving piles; and in such cases beton or concrete mortar may be applied with advantage. No made ground or embankment, that is, earth that has been shifted or moved to produce a level surface, should be trusted as a foundation for a heavy erection until it has had several years to settle and become hard and compact; for notwithstanding an embankment may have been regularly rammed, yet it will always sink or settle to some extent. When, therefore, a building is required upon such a bottom, the foundation trenches should be dug through the made soil to the untouched earth beneath it. This would often lead to a heavy expense both in excavation and in brickwork; therefore the walls may be supported upon arches standing on piers which alone go down to the solid earth. When a foundation trench has been dug even in natural ground, it frequently happens that the entire length may not be equally solid and hard. Should soft places occur, without being very extensive, they may be arched over as above described, the arches taking their abutments upon such portions of wall as are built upon the solid ground. Whenever foundations appear doubtful, the solidity of the earth is tried by driving stakes into it, or by the use of an iron borer. All foundation trenches should be perfectly level at their bottom, and need not be wider than what is merely necessary for introducing and laying the stones or bricks in mortar. If, therefore, a foundation has to be formed in the slope of a hill, that foundation should not follow the slope of such hill, but should be cut in level steps, like a staircase, except that the level portions may extend considerable distances.

When the erection about to be constructed is not a wall of equal thickness and weight throughout, but consists of piers with windows or openings between them, or of columns that are heavy or have to carry large weights, the pressure on the foundation will not be equal, but will produce a greater strain immediately under such columns or piers than in other places. A footing or foundation of equal strength would, therefore, be subject to bend, break, or loose its right lined form To resist such unequal pressure, inverted arches, or what are technically called *inverts*, are resorted to. These are nothing more than the common arch, constructed of stone or brick, (but generally of the latter material,) but placed with the convex surface of the arch downwards, instead of in its usual position. Such arches, of course, require no centring for their construction, but the materials of which they are formed are supported either in regular curved foundations cut to a mould board or template, if the ground is stiff clay, or any soil that will hold its shape without crumbling, or falling down, or more frequently in concavities formed in a brick or stone foundation which is commenced in the usual right lined horizontal direction. Inverted arches are also very useful in places where foundations may be liable to be undermined, disturbed, or carried away by a flow of water.

The greatest danger to be apprehended in a foundation of natural soil which may appear good, is from its not being equally hard and trustworthy in every part of its length. To obviate which, it is very customary to lay down thick oak, or other planks, to build upon; but this is by no means a good practice, unless the foundation is so deep as to insure such timber being constantly under water. When this is not the case the timber will soon decay; and whenever this occurs the wall is left without support, or perhaps partially supported, from one part of the platform decaying more rapidly than another. In all cases, therefore, where such assistance is necessary it should be obtained from large flat stones of the slab formation; and some of the varieties of slate and York paving are excellent for this purpose. Such stones should be of sufficient thickness to sustain the superincumbent weight without breaking, and the more effectually to guard against this accident, they should be very carefully bedded, or be so placed on the ground as to leave no hollow places under them. This, in general, may be guarded against by digging the foundation trench wider than is necessary, making the bottom to fit or suit the under surface of the stone, (should it not be quite flat,) and then driving earth under the stone at its sides by a stone hammer, after it is placed.

The ground under a foundation is sometimes of so loose and open a nature that it may not prove solid, even if excavated to a very considerable distance, and when this is the case the driving of *piles* may become necessary. Piles are usually made of whole round timber cut to proper lengths, or of baulks, from which the rough bark and any projections have been hewn off, to fit them for passing more readily into the ground; and the descending end is pointed for the same object. Should the ground be hard or stony, the end will require the assistance of a wrought iron point, which is formed with four spreading tails with holes through them for nailing them to the sides of the point of the pile; the upper end of the pile must likewise be encompassed by a strong wrought iron hoop, to prevent it from splitting in the driving. The points, or *shoes*, may be made of cast iron for soft, sandy, or clay soils, that being a cheaper material, and the point, or shoe, being lost for ever; but one hoop will serve for many piles, because it is only useful during the driving, and is afterwards taken off to serve for other piles. Piles are used for a twofold object, one of which is to condense or harden loose ground, which they do on the principle of the wedge, by inducing lateral pressure; the other is to transfer the load to a deeper part of the soil than that which has been laid bare, when it is found that the ground increases in solidity as it descends, or that a solid stratum of soil exists under that which has been laid open. To produce the first effect the piles need not be more than from four to six feet in length, and their lower part should be squared and gradually tapered from the point to the head, so as to give them the shape of elongated pyramids; and if charred, before driving, they will not only enter the ground more easily but will be more durable. For the second object the piles must of course be long enough to reach the hard ground from which the support is proposed to be derived; and whenever piles are long they ought to have but little taper or diminution of size, or the difficulty of driving them will be much increased. Every pile should, however, have some taper, because that affords material assistance in enabling it to support its load. That timber should be selected for piles that is known by experience to be least liable to decay under ground, and it should be straight grained and tolerably free from knots, otherwise it will be liable to break in driving. Considerable care is also necessary in shaping the points to have the angles on all sides equal with their common summit in the centre or axis of the tree; for if this is not attended to, the pile cannot be driven in a perpendicular straight forward direction. Small piles are driven by a three hand maul, but large ones require a pile driving engine.—*Millington.*

FOUNDER. A disease in the feet of horses. It consists in inflammation of the laminæ which unite the wall of the hoof to the coffin-bone, and of the vascular parts of the sensible foot immediately adjacent to these laminæ. It sometimes attacks only one foot, sometimes two, and sometimes all the four; but, in a great majority of instances, it attacks either one or both of the front feet. A chronic form of it sometimes occurs, and exhibits symptoms somewhat similar to those of contraction of the hoof; but acute inflammation of the sensible laminæ is what almost all farriers particularly designate founder.

This disease is occasioned by overstraining of the laminæ from long standing, by prolonged or excessive driving on hard roads, by congestion from long confinement, by sudden reaction from standing in snow after being heated, or from covering with warm litter after prolonged exposure to cold, by sudden change of diet from a comparatively cool to a comparatively heating kind of corn, and by translation of inflammatory action from some other part of the body, and particularly from the eyes in ophthalmia or from the lungs in pneumonia. In the early stages of founder, a horse evinces great pain, shows excessive restlessness of foot, and tries to lighten the pressure of his body on the diseased feet; in the more advanced stages, he fevers, breathes hard, has violent throbbing in the arteries of the fetlock, lies down, stretches out his legs, and sometimes gazes wistfully upon the seat of the disease; and in the ulterior stages, if no efficient remedies have been applied, the diseased feet either naturally recover their healthy condition, or they suppurate, slough, cast part or all of the hoof, and gradually acquire a small, weak, new hoof, or they undergo such mortification and change of tissues as to render the animal permanently useless.

The shoe of a foundered foot must be removed; the wall and the horny sole must be thinned by the knife and the rasp; and blood must be let, not later than the second day of the disease or the early part of the third, from the toe and the jugular vein; and if this last remedy have been early enough used, it may, if necessary, be repeated; but it ought, on no account, to be attempted after suppuration has commenced, for it might then produce mortification. Blistering is sometimes practised; but it has a tendency rather to increase the inflammatory action than to diminish it. Vastly more suitable appliances subsequent to bleeding are fomentations, evaporating lotions, wet cloths, and moist poultices; and an exceedingly good one, if due precautions be used against subsequent reaction, is swathing with thin and narrow cloth-bags half-full of snow or pounded ice. The animal ought to have light and spare diet, to receive some diaphoretics or febrifuges, and to be allowed to select and retain whatever posture he pleases. When founder ends in the re-acquirement of small, weak, and contracted hoofs, the horn may be thinned, the hoofs scored, and the cornets blistered.

FOUNTAIN. Either a natural issue of water from among the strata of the earth's crust, or an artificial flow of water, downward by cascade or upward by jet, as an ornament in a park or garden.

The natural fountain may be, in all respects, a natural issue of water from the surface-ground of a country or of a cavern, and it is then a natural spring; or it may be an issue of water from the bottom of a narrow and moderate artificial excavation, and it is then a common well; or it may be the uprising of a column of water from deep-lying strata in an artificial bore drilled through the superincumbent strata, and it is then an artesian well. See the articles SPRING, WELL, ARTESIAN WELL, AUGER, DRAINING, and GEOLOGY.

The artificial or ornamental fountain may be either a cascade falling from an unseen source above, or a jet rising into the air from a visible source below; and whether jet or cascade, it may be either rustic, plainly architectural, or ornately architectural. The rustic fountain, if a cascade, falls from rock-work above, and forms rills below,—and, if a jet, rises from a rock-work base, and falls either against rock-work or into a surrounding pool; the plainly architectural fountain, whether cascade or jet, is constructed of common though neat masonry; and the ornately architectural fountain affords scope for all the innumerable varieties of design which the united taste and powers of architect, sculptor, and landscape gardener can produce,—and also for all the varieties of architectural and sculptorial absurdity which bad taste and purse-proud folly can perpetrate.

FOW. See FORK.

FOWL. See COCK and POULTRY.

FOWL'S DUNG. See EXCREMENT and GUANO.

FOX. A well-known animal, a native of almost every quarter of the globe, and esteemed the most sagacious and crafty of all beasts of prey. The former quality he demonstrates in his mode of providing himself an asylum, and the latter in his schemes for catching his prey. The fox belongs to the genus *canis* of naturalists, and has been formed into a sub-genus, on account of its longer and more bushy tail, more pointed muzzle, nocturnal pupils, less slanting superior incisive teeth, fetid odour, and habit of burrowing. All the species are equally wily and voracious, greedily devouring birds and small quadrupeds, disliked and betrayed by most of those animals who have a dread of his attacks, and extremely difficult to be tamed, even when caught very young. The fox, like the wolf, is the constant object of persecution, from the ravages he commits, not only on domestic animals, but also on some fruits. He has been the destroyer of grapes from the earliest records. He devours honey, sucks eggs, carries off poultry, and, in fact, commits mischief in every possible form.

The common fox of Europe (*C. vulpes*) exhibits a great degree of cunning in digging young rabbits out of their burrows. He does not enter the hole, as, in such case, he would be obliged to dig several feet along the ground under the surface; but he follows their scent above, till he comes to the end where they lie, and then, scratching up the earth, descends immediately upon, and devours them. The den of this fox is so contrived as to afford the best possible security to the inhabitant, being situated under hard ground, the roots of trees, &c., and furnished with proper outlets for the purposes of escape, if necessary. He is one of those animals that are made the objects of diversion in the chase. When he finds himself pursued, he usually makes for his hole, and, penetrating to the bottom, lies quiet till a terrier is sent in to him. If his den is under a rock or the roots of trees, which is often the case, he is safe, for the terrier is no match for him there, and he cannot be dug out. When, as is generally practised, the retreat to his den is cut off, his stratagems and shifts to escape are various. He always seeks the most woody parts of the country, and prefers such paths as are most embarrassed by thorns and briers. He runs in a direct line before the hounds, and at no great distance from them. When overtaken, he fights very obstinately. He possesses astonishing acuteness of smell. During winter he makes a continual yelping, but in summer he is usually silent. In Japan the natives believe him to be animated by the devil; and their writings are full of strange accounts respecting him. There are several species of the fox found in this country. Mr. Macgillivray, in a paper read before the Wernerian Nat. Hist. Society, says:—

"It appears to me that there are four races or varieties of the fox in Scotland.

The first of these, the hound-fox, is tall, slender in the limbs, with a very attenuated muzzle; a bright reddish-yellow fur; the lower parts of the body greyish-white; the tail greyish-yellow, with long black hairs scattered towards its extremity; and about three inches of its extremity white.

The second, the cur-fox, is similar to the first variety in colouring, but is smaller, with the body deeper, and the legs shorter. These two races seem to pass into each other, and can scarcely be distinguished except in the extremes.

The third, the dog-fox, is compact in form, with comparatively short limbs; the head rather broad, the muzzle pointed; the fur deep red; the lower parts brownish-red; the tail yellowish-grey, darkened with black hairs, and having the tip of the same colour.

The fourth, the mastiff-fox, is larger and stronger; its limbs more robust; the head much broader; a dull, greyish-yellow fur, profusely interspersed with white hairs; the tail dusky, with long black hairs scattered over it, and a small white tip.

The first and second varieties are of common occurrence in the lower districts of the country. The third is very rare, and individuals of it being considered inferior specimens of the species, it is not to be seen in collections. The fourth kind seems peculiar to the Highland districts. The first variety approaches in its general form to the most characteristic variety of the shepherd's dog. The head is of ordinary size, with a long, attenuated muzzle; the ears roundish, erect, with a slit at the lower part of the outer margin; the eyes of moderate size; the mouth opening to beneath the middle of the eye; the snout small, the nostrils terminal, with a lateral slit; the upper lip grooved; the neck of moderate length, but strong; the body rather long and compact; the limbs longish and rather slender; the tail reaching to the feet. On the fore feet are five toes, the inner small and raised from the ground; on the hind feet four toes; the claws slightly arched, compressed, bluntish, grooved beneath, near the end; those of the hind feet broadest.

$$\text{Incisores}\ \frac{6}{6}\quad \text{Canini}\ \frac{2}{2}\quad \text{Molares}\ \frac{12}{14}$$

Incisors of the upper jaw incurvate, rounded, with two small lateral processes, excepting the two larger side ones, which are caniniform. Canini tapering, incurvate, long, distant from the incisors. Laniarii 4; 1st small, compressed, obtuse, with a posterior shoulder; 2d and 3d nearly equal, compressed, tapering, with two shoulders; 4th much larger, oblique, with an anterior tubercle, a central point, and a posterior edge. Of the two molares, the anterior is much larger; both are similar in form, transverse, with two external tubercles, one internal, and a projecting margin. In the lower jaw the incisors are smaller, rounded, with an external lateral process, the two outer considerably larger. Canini close to the incisors, smaller than those above, and more curved. Of the laniarii the first is very small, rounded, with a posterior shoulder; the rest nearly equal, with anterior and posterior shoulders, the last one with two posterior. The next tooth, which is the largest, combines the two forms, its anterior part being sharp-edged with two points, the posterior, lower, with four unequal tubercles. The first grinder has four tubercles, and the last, which is very small, has three. The fur is rather soft, pretty close, longish, and consists of a fine woolly covering, and long hairs of a stiffish texture; the tail bushy; the hair of the limbs and face short; the soles covered with hair, excepting the tuberculous eminences on which they have been worn. The general colour is yellowish-red, pure on the sides of the neck and chest, and lower sides of the abdomen, mixed with white hairs on the shoulders, thighs, upper flank, sacral region, and tail. The snout and lips are blackish; the inner surface and edges of the ears whitish, outer part of the ear pure black. Tail pale greyish-yellow, the tips of the hairs brownish-black, its extremity white to the length of about three inches. Lower part of the checks, fore part of the neck, lower surface of the body, inner thighs, pudic region, a narrow line down the fore part of the leg, and the hind and inner part of the fore legs, greyish-white. Fore part of all the feet, brownish-black, that colour extending from the toes to near the cubital and knee-joints; hair of soles deep red; claws light brown; mystachial bristles black.

The male and the female are precisely similar in external appearance; nor does there seem to be much difference in size.

Dimensions of two individuals:

	Male.		*Female.*	
	FT.	IN.	FT.	IN.
From the tip of the nose to the root of the tail	2	6	2	4½
Length of the tail (not including the hair)	1	4	1	3½
Total length (including the hair) . .	4	0	3	10
Height at the shoulder } (following the flexure of the limbs)	1	6	1	6
Height at the rump } (following the flexure of the limbs)	1	7½	1	7
From the nose to the occiput . . .	0	7	0	7

The second variety is similar to the first, but smaller, with the limbs shorter, the colour of a deeper red, and having a larger mixture of white hairs on the parts mentioned.

Of the dog-fox the following is a description taken from a male shot in Peebles-shire, in December 1835. The general colour is yellowish-red, the forehead, shoulders, and haunches with greyish-white hairs interspersed. There is a dark patch between the mystachial bristles and the eye, and the lower jaw is dusky. Edge of upper lip, base of lower, throat, and fore neck, with a short band down each humerus anteriorly and internally, and another on the middle of the breast, greyish-white. The lower parts of the body are brownish-red; the axillæ and groins light red; the scrotal hairs yellowish-white; outer surface of ear black, inner pale greyish-yellow. Legs dark brownish-red, fore part black from the toes up to the cubital and knee joints; hind part of the hips deep red; tail yellowish-grey, the tips of the long hairs brownish-black, the extremity of the same colour; claws yellowish-grey.

	FT.	IN.
From the tip of the nose to the root of the tail	2	3
Length of tail	1	3
Total length (hairs of tail included) . .	3	8
From the nose to the occiput . . .	0	6½

A skin and skull of a fox procured in Sutherland by Sir William Jardine belonged decidedly to the fourth variety, the mastiff-fox. The scull greatly exceeds that of the other kinds in the width of its zygomatic arches, and the size of the cerebral cavity. The fur is longer and coarser, of a duller red, and much intermixed with white hairs; the lower parts light grey, and the extremity of the tail white for about three inches.

I have reason to believe that similar varieties exist in other mammalia inhabiting this country. For example, the red deer of Lewis and Harris are much smaller and of a dunner colour, than those of the mainland. Of the weasel, there is a variety much inferior in size to the common; and of the water rat I am aware of three, the common brown, the black, and an intermediate kind. The latter, as well as the black, may be a distinct species, it being considered as such in the neighbourhood of Keith, where it is said to lay up a store of potatoes for winter-provender. Whether the different kinds of fox above described breed together, or remain distinct, is as yet unknown, nor are we in possession of any positive knowledge as to their peculiar habits."

Arctic Fox (*C. lagopus.*) This is smaller than the common fox, with a sharp nose, and short, rounded ears, almost hid in its fur; its hair is long, soft, and somewhat woolly. Its legs are short, having the toes covered with fur, like those of the hare; hence its specific name. It inhabits the countries bordering on the Frozen ocean in both continents. In October and November, like the common fox, it is the most sleek, and has the best coat of hair, which, later in the season, become too thick and ragged. As the winter commences, it grows perfectly white, changing colour last on the ridge of the back and tip of the tail. In April and May, it begins to shed its coat. In June, it drops its cubs, from three to five in a litter. This fox preys upon various small quadrupeds, such as hares, marmots, &c., as well as upon partridges and other birds, the carcasses of fish left on shore; and, driven by necessity, it will eat indiscriminately whatever may promise to allay its hunger. We are informed by Mr. Crantz, that it exerts an extraordinary degree of cunning in taking fish. It goes into the water and makes a splash with its feet in order to attract them, and, when they come up, immediately seizes them. It is taken with great facility in traps, and it is a singular circumstance, that these animals will prey upon each other, when they find individuals killed, wounded, or caught, as readily as upon any other food. Their skins are not of any great value.

Black Fox (*C. argentatus.*) This species is strikingly similar to the common fox, and is only distinguishable by its copious and beautiful fur, which is of a rich and shining black colour, having a small quantity of white mixed with it in different proportions. It inhabits the northern parts of Asia and America; but a comparison of those of this country with the foreign will, in all probability, prove them to be distinct, as has been suggested by Cuvier.

Red fox (*C. fulvus*). This species is found throughout North America, and has been considered as identical with the common fox of Europe, though there can be no doubt of their difference. The general colour of this fox, in summer, is bright ferruginous on the head, back and sides. Beneath the chin it is white, whilst the throat and neck are of a dark gray. The under parts of the body towards the tail are very pale red. It is about 2 feet long and 18 inches high. The skins are much sought for, and are employed in various manufactures. When caught young, they may be domesticated to a certain degree, but are always unpleasant from the fetor of their urine.

Crossed fox (*C. decussatus*). This differs very much from the common fox. The colour of his fur is a sort of gray, resulting from the mixture of black and white hair. He has a black cross on his shoulders, from which he derives his name. The muzzle, lower parts of the body and the feet are black; the tail is terminated with white. It inhabits the northern parts of America, and may, perhaps, be only a variety of the black fox.

Gray fox (*C. cinerio-argentatus*) is common throughout America, more particularly in the neighbourhood of habitations. Its general colour is gray, becoming gradually darker from the shoulders to the hips. It has a sharp head, marked by a blackish-gray triangle, which gives it a peculiar physiognomy. The tail is thick and bushy.

Swift fox (*C. velox*, Say). This beautiful little animal, which was first accurately described by Mr. Say, inhabits the great plains which lie at the base of the Rocky mountains. It is much smaller than the other American species, and forms its habitation by burrowing. It is distinguished by its extraordinary speed, which appears to surpass that of any other animal. It can pass the fleetest antelope, and seems rather to fly than to touch the ground in its course. It is even stated, that such is its rapid motion, that the effect produced on the eye is that of a line swiftly drawn along the surface, the parts of the animal's body being wholly undistinguishable. Its body is slender, and the tail rather long, cylindrical and black. The hair is fine, dense and soft. It somewhat resembles the *C. corsac*, which inhabits the vast plains of Tartary.

FOXBANE,—botanically *Aconitum Vulparia.* A continental species of monkshood. Its root is perennial; its stem, 3 or 4 feet high; and its flower pale yellow. It is hardy and ornamental; and has a bad fame among the other "baneful" kinds of aconite. See the article ACONITE.

FOXGLOVE,—botanically *Digitalis.* A genus of ornamental plants of the figwort tribe. The purple or common foxglove, *Digitalis purpurea*, is a well known indigenous biennial of Britain, a frequent inhabitant of cottage and villa flower-gardens, and one of the most powerful British members of the materia medica. Two popular names of it in Scotland are bloody fingers and dead man's fingers; and both allude to the shape and colour of its flowers. It abounds in gravel pits and other waste places with a sandy or gravelly soil; and is frequently met with on many kinds of dry banks, and by the side of dry hedges. Its root is fibrous and knotty; its stem is cylindrical, downy, leafy, and about 4 feet high; its root leaves grow in tufts, and are ovate, pointed, wrinkled, velvety, bluntly serrated, and about 8 inches long and 3 inches broad, and have fleshy and bordered footstalks; its stem leaves are considerably asunder from one another, alternate, lanceolate, wrinkled, and velvety; its flowers are finger-shaped or oblongly campanulate, about the size of the little finger of a man's glove, hairy at the mouth, bright pinkish purple, and somewhat numerous, and they grow in such a pendulous manner on one side of the upper part of the stem as to form a massive and very handsome terminal spike, and they usually bloom from June till September. A variety with white flowers is sometimes met with in a wild state, and is very generally cultivated on the flower-border.

The leaves of this plant are the part used in medicine; they ought to be gathered in a perfectly fresh state, when the plant is in flower; they should be divested of the midrib, and carefully dried, each leaf by itself, either in the sunshine or in a warm kitchen; they ought not to be used when kept longer than a year, or when they have acquired a blackish colour; and, whether whole or reduced to powder, they should be kept in opaque, air-tight vessels. Either an infusion or a tincture of the leaves contains all their medicinal properties; and is of very eminent service in inflammatory, febrile, and heart diseases of both man and beast. Foxglove, internally exhibited, in either substance, infusion, or tincture, is almost as sedative as opium, powerfully affects the action of the heart, produces temporary intermittence in the pulse, abates inflammatory action, stimulates the kidneys, and has been found serviceable in dropsy, hemorrhage, scrofula, consumption, and mania. But it requires great judgment in the administration; and when it is given in overdose, it acts as a narcotic poison, and must be combated homœopathically by cordials, alcohol, and opium, or counteractingly by blistering. It is freely recommended in cattle medicine, and is a very valuable appliance of the veterinarian in most cases of fever or inflammation in either horse or cow; but it ought never to be touched by any quack upon a farm, or any half-skilled or itinerant cattle-doctor. The fresh leaves are used externally, or as cataplasms, for healing old sores, and reducing scrofulous tumours.

About two dozen species of foxglove have been introduced to British gardens from continental Europe; two of these are biennials, one is an evergreen undershrub, and all the rest are hardy, perennial-rooted herbs; some are yellow-flowered, some white-flowered, some brown-flowered, some two-coloured, and one orange-flowered; and all are more or less beautiful, and bloom in the latter part of summer and the early part of autumn.

FOXTAIL-GRASS. See ALOPECURUS.

FOXTAIL-ROOT. A ligneous root or radicle which projects into a drain or rill or rivulet, and sends out a profusion of fine filamentous fibres upon a prolonged axis, so as to produce an object of similar appearance to the tail of a fox. The foxtail-roots of some trees and shrubs are great pests to drainage, and sometimes completely obstruct the ducts of drains.

FRACTURE. A break or separation in the bone of an animal, from external violence. When the injured bone is simply cracked or broken through, the fracture is simple; when the bone is bruised, crushed, or broken into splinters or fragments, the fracture is compound; and when the bone is merely pushed out of its socket, without being cracked or splintered, the injury is a dislocation. When a simple fracture occurs near a joint, it is liable to be mistaken for a dislocation. The chief cure for a simple fracture is to adjust the broken parts accurately to each other, and fix them in their position by means of wooden splints and strong bandages; the chief cure for a compound fracture is to saw away projecting splinters, remove loose splinters, clean and close the wound, adjust the chief parts of the broken bone, soothe with fomentations and support with soft bandages till cicatrization be effected, and then proceed as in simple fracture; and the chief cure of a dislocation, unattended by crack or splinter, is to bring back the displaced bone into its socket, and apply either plaster or bandage.

The reduction of a fracture in any important bone of a horse is so very difficult to be effected, and so uncertain in its restorative effects, and would be followed by so long a period of inaction and of expensive feeding, that a British horse-owner scarcely ever thinks of attempting it, but consigns the animal to destruction. Yet many a fracture which condemns a horse to death in Britain, would be cured on the Continent, and is, in any ordinary circumstances, quite capable of both successful and economical treatment.—A fracture in the leg of a cow or an ox may be cured in the common way, with the help of keeping the animal cool and quiet. A compoundly fractured leg of an ox has even been successfully amputated, and a wooden leg put in its place.—A fracture in the leg of a sheep may be cured by cutting away the adjacent wool, adjusting the broken bone, and winding round a little web or roll of gummed brown paper as a substitute for splints and stiff bandages.—A fracture in the limb of a dog will heal itself, yet probably not without rendering the limb crooked; and it may easily be artificially treated in the same manner as in larger animals.

FRACTURE. A break or separation in the trunk or branch of a tree or shrub. A fracture of a small stem or branch, provided it be only partial, and do not extend deeper than through the bark to the outer layers of the wood, may be cured, in spring or summer, simply by closely re-adjusting the part, and propping it in its position.

FRAGARIA. See STRAWBERRY.

FRAGRANCE. Agreeable odour. All sweet-smelling plants, but particularly such as emit agreeable odours from their leaves or from their whole substance, are fragrant; and many plants not beautiful or otherwise interesting, are classed with ornamental plants, and cultivated in the flower-garden, on account of the fragrance of their flowers or foliage.

FRAME. A small structure, with sides of wood or of similar material, and with glazed roofs, for the protecting and rearing of slightly tender species of esculent and flowering plants. Very small frames with single lights, or somewhat larger ones with two lights, are used for raising seedlings, and for similar processes, and may be regarded as only a huge kind of hand-glasses. Frames of strong whited brown paper, or of printer's strong white paper, strengthened and consolidated with a slight coat of boiled linseed oil, are sometimes used as exceedingly efficient substitutes for matting, in the shading and protecting of forced crops or of any kinds of vegetables usually raised beneath hand-glasses; and these have light yet firm wood-work, and may be of any convenient size, from a size similar to that of the small one-light frames to an ordinary or normal size of about 10 or 12 feet in length, 4 in width, and 2½ or 2¾ in height. Frames for melons, cucumbers, pine-apples, ligneous seedlings, and all the other bulky and most important departments of frame culture, are as requisite as greenhouses, and ought to be constructed with equal science, care, and stability. Each of their lights should be about 40 inches in width, and ought to have its lines of lead or wood in a downward direction, in order that they may obstruct neither the descent of water nor the play of light. Frames cannot conveniently have more than three lights; and those of larger size ought to be constructed with partitions to divide them, and with moveable joints to allow them to be easily taken to pieces. Frames vary in length according to the width and number of their lights; but all ought to be about 5 feet in breadth; those for melons and plants of similar height and habits, may be 15 inches high in the back, and slope to 7 inches in the front; those for pine-apples must be at least 3½ feet high in the back, and slope to 1½ foot in the front; and those for other classes of plants of intermediate or superior height, must have dimensions of corresponding magnitude. When heat is desired more than light, the inside of the frame must be painted black; and when light is desired more than heat, the inside must be painted light.

FRANCISCEA. A genus of ornamental tropical plants, of the nightshade family. Pohl's species, *F. Pohliana*, was introduced to Britain in 1844. It is a small, upright, branching shrub; its stem is purplish; its leaves are elliptically lanceolate, and pubescent on both surfaces; and its flowers have a pale violet colour, and are produced in loose, terminal, roundish heads.—The one-flowered species, *F. uniflora*, was introduced to Britain from Brazil in 1826. It is a small evergreen shrub; its stem usually attains a height of about a yard; and its flowers are fragrant, and have a combination of white and purple colours, and bloom from June till August.—The hydrangea-shaped species, *F. hydrangeiformis*, is a coarse-looking shrub, and was introduced from Brazil in 1844. Its leaves are large, rough, and oblong-oval; and its flowers are produced in loose heads at the ends of the shoots, and resemble those of the one-flowered species, but are not fragrant.—About a dozen other species are known.

FRANGULA. See ALDER (BERRY-BEARING).

FRANKENIA. A genus of hardy plants, chiefly evergreen trailers and creepers, forming the type of the natural order Frankeniaceæ. This order is nearly allied to the carnation tribe, but is distinguished from it by wanting a separate central placenta, and by the peculiar position of its seeds. Its plants, for the most part, inhabit arid situations, and occur in Europe, Africa, and South America; and they derive their chief interest from the wildness and singularity of their form and habit. Three genera are comprised in the order; but two of these are unknown in Britain.—The genus Frankenia comprises two English species, 7 or 8 introduced exotic species, and 7 or 8 known but unintroduced exotic species. The two English species are popularly called sea-heaths; and they sometimes give their name to the whole genus. The powdery species, *F. pulverulenta*, is a curious and very rare annual of some parts of the English coast. Its stem is prostrate, forked, and downy; its leaves are powdery-looking below, and smooth and green above; and its flowers are pale red, and bloom in July. The smooth species, *F. lævis*, is perennial-rooted and comparatively abundant; and, unlike the great majority of its order, it inhabits salt-marshes or wet and muddy parts of the coast. Its root is ligneous; its stem is downy, forked, and quite procumbent; its branches are leafy and somewhat ascending; its leaves are revolute, fringed, and smooth; and its flowers grow from the forkings of the stem, and are flesh-coloured, and bloom in July and August. All the introduced exotic species are singular-looking evergreen trailers; and some are hardy plants, while others require the heat of the greenhouse.

FRANKINCENSE. A fragrant and resinous exudation of various species of trees of the terebinth and pine families. The frankincense of ancient times is well known, from both civil record and the sacred scriptures, to have been a substance of great value and of very delightful odour. It is classed, in the Divine record, with myrrh and the fragrance of the rare and exquisite aloe-tree; it was burnt, in the sacred service of the Jewish Temple, as a type or emblem of the rich moral odours of prayer and intercession; and it passed by imitation into the services of heathen temples, and was there burnt in the most fragrant pastiles. It may have been obtained from some species of *Boswellia*, whose richly odorous exudations constitute the modern gum olibanum,—a name apparently altered from "oil of Lebanon;" or from some species of *Amyris*, whose exudations are popularly believed to exceed those of the myrrh-tree in luxuriousness of odour; or from some congener of the myrrh-tree itself, which inhabits the very Arabia Felix whence the ancient frankincense is supposed to have been procured, and which was totally unknown till of late years to botanists, and was conjectured to be a mimosa, but is now ascertained to belong to the terebinth family; or from some undescribed species of juniper, one of whose best-known, tall, ornamental shrubs, brought to Britain from the south of Europe, bears botanically the name of *thurifera* or frankincense-bearing; or from some undescribed or obscurely known species of the pine family, many of whose species are opulent in the fragrance of their resins, and not a few oriental species of which, formerly quite unknown to science, and ascertained to possess very singular properties, have been discovered by quite recent research. But the fact is, that, though we know a great deal historically about ancient frankincense, we know absolutely nothing botanically. "Frankincense," says Phillips, in his History of cultivated vegetables, "was obtained from trees which grew in Arabia Felix. The incense-trees grew only in that part of Arabia inhabited by the Sabæans; and so strict were their laws respecting them, that persons were not permitted even to see the trees, except those appointed to take care of them. The valley where they grew was surrounded by mountains, and was situated eight days journey from Sabota, now Sanaa, the capital, whither the incense was conveyed on camels. At the time the frankincense was taken to Alexandria to be tried, refined, and made up for sale, the workmen were attired only in short trousers, which were sewed up and sealed, to prevent the possibility of their concealing any portion of this valuable drug."

Modern frankincense is a widely different affair from the ancient, and is the produce of some quite common pines and firs, and particularly of the Norway spruce. "The exudations or tears of the spruce fir," says Anderson's Commercial Dictionary, "constitute the substance called *thus*, or common frankincense. It is a solid, brittle resin, imported in little balls or masses, of a brownish or yellowish colour on the outside, internally whitish or variegated with whitish specks, of a bitterish, acrid, disagreeable taste, without any disagreeable smell." The same substance, with the same name, figured in quite recent books on horse and cattle medicine, and in nearly all the old pharmacopœias; but it may be regarded as now identified in both name and character with the finer kinds of yellow resin or with Burgundy pitch. English botanists give the name of frankincense, par excellence, to a North American timber pine, which was introduced to Britain in the early part of last century, *Pinus Tæda.*

FRASERA. A hardy, ornamental, biennial-rooted plant, of the gentian tribe. It constitutes a genus of itself, and takes for its specific name *Caraloninensis;* and it was introduced to Britain from North America about half a century ago. Its stem usually attains a height of about 4 feet; and its flowers have a combination of green and yellow, and bloom in July and August.

FRAXINELLA,—botanically *Dictamnus.* A genus of hardy, perennial-rooted, ornamental, herbaceous plants, of the rue tribe. Two species or varieties of it, *Dictamnus fraxinella* and *Dictamnus albus*, the former with purple flowers, the latter with white flowers, and both about a yard high and eminently beautiful, were introduced, about 250 years ago, to Britain from Germany. The root of each strikes deep into the ground, and annually enlarges its head; the stems are numerous and leafy; the leaves are alternate and pinnate, each comprising 3 or 4 pairs of oblong folioles, and a terminating odd one; and the flowers are produced in a long, pyramidal, loose spike, and bloom from May till July. The roots were formerly used as cordials and cephalics, and as preventives of infection; and the whole plant, when gently rubbed, emits an odour like that of lemon peel. A species with narrow leaves and lilac flowers, and only about two-thirds of the height of the old species, was introduced about 25 years ago from Altai.

FRAXINUS. See Ash.

FREE-MARTIN. The seemingly female twin of a bull calf. The majority of apparent heifers, which have been produced as twins of bull-calves, are more or less hermaphrodites; and some possess an almost equal balance of the peculiar organisms of male and female; and all these are necessarily and irremediably barren; but a few have a sufficiently distinct and full development of all the female organs, to be true heifers, and fully capable of becoming productive cows. Thoroughly hermaphrodite free-martins have a lumpish appearance proper to neither cow nor bull; and, if they belong to a good breed, they are excellent fattening animals for the shambles.

FREE-STONE. A well-known building material. The name of this stone is derived from the freedom with which it may be worked or wrought into any particular form; for all the varieties of this stone have no disposition to break in one direction more than another, and one of its leading characteristics is, that although durable against weather, yet it is so soft that it may be sawed by the proper stone-cutter's saw, or may be worked into any desired form by the chisel and mallet. This variety of stone is, therefore, constantly resorted to for all ornamental purposes, such as carving the capitals of columns, friezes, and mouldings, as well as for the building of stone walls whenever it is necessary that their surfaces should be smooth and handsome. Free-stone is always granular in its texture, although the grains may vary in magnitude, and are even occasionally crystalline in their form.—Marble, in all its varieties, ranks as the first or most valuable of all the free-stones, on account of the large masses in which it is formed, its great durability, its not absorbing water, the ease and certainty with which it may be worked even into the finest ornaments, the compactness of its grain and its hardness, which enable it to receive a high and permanent polish, and its not being sensibly affected by heat and cold, or any fluctuations of season.—Next to marble, in point of utility, firmness of grain, and durability, may be ranked the fine grained white sand-stone, which consists of fine siliceous or flinty sand, held together by a peculiar natural cement, that binds the whole into a solid, uniform, compact mass, but still is so small in quantity that it cannot be perceived between the grains, so that the whole stone appears as if formed of fine sand. On account of the scarcity of marble in England, this stone is alone used for all the best buildings, and as it is found most abundantly in the Portland rocks, on the south coast of the island, it is universally known throughout that country under the name of Portland stone. When clean it is very nearly white, will bear fine carving, and it is very strong and durable, not being at all affected by water, frost, or exposure to air. It will not take a polish like marble; but as this stone is hardly ever polished on the exterior of buildings, the one stone can hardly be distinguished from the other, except on close inspection. St. Paul's Cathedral, the Monument, the Royal Palace, and all the fine buildings of London, are built of this stone.—There are other varieties of free-stone, but they are very soft, particularly when *green*, a term applied by workmen to stone fresh from the quarry; for almost all stones either become hard by age and exposure to the atmosphere, or they *slack*, or become friable, and sometimes even drop to powder; and, of course, this last class is wholly unfit for building purposes. A very useful stone, called by mineralogists *oolite*, from its similarity in appearance to the roe of a fish, makes an extensive formation nearly through the middle of England, beginning in Somersetshire, and taking a north-east direction for about 150 miles. It has a yellowish-white colour, is wholly calcareous and granular, its grains sometimes being as fine as sand, and, at others, hollow and as large as peas, when it is called pea-stone. They are united by natural calcareous cement, which is quite visible to the naked eye; but the fine grained stone is alone used for building, and the whole city of Bath is built with it, on which account it has, very generally, obtained the name of Bath-stone. When new, it is so soft that it is cut into any required form by a common carpenter's hand-saw, and is also worked by the chisel; notwithstanding which, and its being absorbent, it is not affected by weather, and hardens and preserves its form remarkably well. It is on this account considered valuable, for it may be worked very cheaply, and produces a handsome appearance.—*Millington.*

FREE-WARREN. A place privileged by grant or prescription for keeping hares, conies, partridges, and pheasants. The owner of it has an exclusive right of destroying game within its limits; and he retains this right even when it is situated on another person's estate. But free-warrens have almost passed into desuetude; and the name of warren is now applied chiefly to grounds set apart for breeding hares and rabbits.

FREEZING. The transformation of a fluid body into a firm or solid mass, by the action of cold. The process of congelation is always attended with the emission of heat, as is found by experiments on the freezing of water, wax, spermaceti, &c.; for in such cases it is found, that a thermometer dipped into the fluid keeps continually descending as this cools, till it arrives at a certain point, being the point of freezing, which is peculiar to each fluid, where it is awhile stationary, and then rises a little, while the congelation goes on; at the same time, the bulk of the body is expanded. The prodigious power of expansion evinced by water in the act of freezing, exerted in so small a mass, seemingly by the force of cold, was thought a very material argument in favour of those who supposed that cold, like heat, is a positive substance. Doctor Black's discovery of latent heat, however, has afforded an easy and natural explanation of this phenomenon. He has shown that, in the act of congelation, water is not cooled more than it was before, but rather grows warmer; that as much heat is discharged, and passes from a latent to a sensible state, as, had it been applied to water in a fluid state, would have heated it to 135°. In this process, the expansion is occasioned by a great number of minute bubbles suddenly produced. Formerly these were supposed to be cold in the abstract, and to be so subtile, that, insinuating themselves into the substance of the fluid, they augmented its bulk, at the same time that, by impeding the motion of its particles upon each other, they changed it from a fluid to a solid. But these are only air extricated during the congelation; and to the extrication of this air we ascribe the prodigious expansive force exerted by freezing water. By what means does this air come to be extricated, and to take up more room than it naturally does in the fluid? Perhaps part of the heat, which is discharged from the freezing water, combines with the air in its unelastic state, and, by restoring its elasticity, gives it that extraordinary force, as is seen also in the case of air suddenly extricated in the explosion of gunpowder.

A very great degree of cold is produced by mixing snow with certain salts. The best salt for this purpose is muriate of lime. If this be mixed with dry, light snow, and the two bodies be stirred well together, the cold produced will be so intense as to freeze mercury in a few minutes. Common salt with snow produces a great degree of cold. Evaporation likewise produces cold. The method of making ice artificially in the East Indies, depends upon this principle. The manufacturers at Benares dig pits in large open plains, the bottom of which they strew with sugar-canes, or dried stems of maize, or Indian corn. Upon this bed they place a number of unglazed pans, made of so porous an earth, that the water oozes through their substance. These pans are filled, towards evening, in the winter season, with water which has been boiled, and are left in that situation till morning, when more or less ice is found in them, according to the temperature of the air; there being more formed in dry and warm weather than in cloudy weather, though it may be colder to the human body. Every thing in this operation is calculated to produce cold by evaporation; the beds on which the pans are placed, suffer the air to have a free passage to their bottoms, and the pans, constantly oozing out water to their external surface, are cooled by the evaporation of it.

In Spain, a kind of earthern jars, called *buxaros*, is used, the earth of which is so porous, being only half-baked, that the outside is kept moist by the water which filters through it; and, though placed in the sun, the water in the jar becomes as cold as ice. It is a common practice in China, to cool wine or other liquors by wrapping a wet cloth round the bottle, and hanging it up in the sun. The water in the cloth evaporates, and thus cold is produced. Ice may be produced at any time by the evaporation of ether. Professor Leslie discovered that porphyritic trap, pounded and dried, will absorb one tenth part of its weight of moisture, and can hence be easily made to freeze the eighth part of its weight of water. In hot countries, the powder will, after each process, recover its power by drying in the sun. This curious and beautiful discovery of artificial congelation, will, therefore, produce ice in the tropical climes, or even at sea, with very little trouble, and no sort of risk or inconvenience. Leslie also discovered that parched oatmeal is even a more powerful absorbent than the whinstone; and with a stratum of oatmeal, about a foot in diameter, and one inch deep, he froze a pound and a quarter of water, contained in a hemispherical porous cup. The meal is easily dried, and restored to its former use.

FREEZING POINT denotes the point or degree of cold, shown by a mercurial thermometer, at which certain fluids begin to freeze, or, when frozen, at which they begin to thaw again. On Fahrenheit's thermometer this point is at $+32$ for water, and at -40 for quicksilver, these fluids freezing at those two points respectively. See Thermometer.

FREIGHT is the consideration money agreed to be paid for the use or hire of a ship; or, in a larger sense, it is the burthen of such ship. The freight is most frequently determined for the whole voyage without respect to time; sometimes it depends on time. In the former case, it is either fixed at a certain sum for the whole cargo, at so much per ton, barrel, or other weight or measure, or so much per cent. on the value of the cargo.

FRENCH BARLEY. See Barley.

FRENCH BEAN. See Kidney-Bean.

FRENCH BERRY. The fruit of the dyer's buckthorn,—*Rhamnus infectorius.* This shrub grows abundantly in the south of France, and particularly in the vicinity of Avignon; and it was introduced to Britain in the latter part of the 17th century, and is sometimes cultivated for ornament in our shrubberies. Its berries are extensively used in the south and middle of France for giving a yellow dye; and, for this purpose, they are gathered unripe, bruised, steeped, and boiled in water; and the liquid thence obtained is mixed with the ashes of vine-stems, and passed through a fine linen cloth. The colour of the dye is a fine yellow, and is most commonly used for silk, and called *stil de grain*, but it is very fugitive, expecially when exposed to sunshine.

FRENCH MARIGOLD,—botanically *Tagetes Patula.* A hardy, ornamental, annual-rooted plant, of the jacobea division of the composite order. It grows wild in Mexico, and was introduced about 250 years ago to Britain, and has long been generally cultivated as a great floral favourite of all classes of florists, and as one of the most beautiful annuals of either the flower-bed or the flower-border. It has a somewhat close resemblance to African marigold, but is more spreading and not so tall, and has smaller and incomparably richer flowers. Its ordinary height is about two feet; and its usual time of blooming is from July till October. Its flowers, from any one paper of the ordinary seed of the seedshops, are single, semidouble, and double, and vary from the utmost plainness of form to a shape and fulness almost as rich as those of a superfine ranunculus, and have a prevalence of yellow and orange colours, but are more diversified in tinting than even in form, and sometimes display a combination of exquisite variegation with much delicacy and extraordinary brilliance. The worst drawback upon beds of this plant is the unavoidable mixation of bald forms and dingy colours with the richest forms and the most glowing tints. The plants flower best when raised upon a moderate hotbed, allowed an abundance of fresh air, and transplanted when about 3 inches high to warm ground or a moderate hotbed at distances of half a foot; and the prime plants may afterwards be taken up with adhering clods of soil, and placed either in pots or singly in the border.

FRET. Flatulent colic in horses. See the article Colic.

FREZIERA. A genus of tender, ornamental shrubs, of the ternstrœmia order. Seven or eight species are known; and all are closely related in both habit and botanical characters to the camellias. One species, called the tea-like, *Freziera theæoides*, and nearly allied in both appearance and organism to the Chinese tea-plants, was introduced nearly 20 years ago from Jamaica to Britain.

FRIAR'S COWL,—botanically *Arisarum*. A curious, hardy, perennial-rooted herbaceous plant, of the order aroideæ. It constitutes a genus of itself, and takes for its specific name *vulgare;* but it was formerly ranked as an arum, and it has a close affinity to that genus. It grows wild in the south of Europe, was long ago introduced to Britain, and has lilac and yellow flowers and a height of 12 or 15 inches. See the article ARUM.

FRICTION. The act of rubbing two bodies together, or the resistance in machines caused by the motion of the different parts against each other. Friction arises from the roughness of the surface of the body moved on, and that of the moving body; for such surfaces consisting alternately of small eminences and cavities, these act against each other, and prevent the free motion that would ensue on a supposition of the two bodies being perfectly polished planes. Ferguson found that the quantity of friction was always proportional to the weight of the rubbing body, and not to the quantity of surface; and that it increased with an increase of velocity, but was not proportional to the augmentation of celerity. He found also, that the friction of smooth, soft wood, moving upon smooth soft wood, was equal to one-third of the weight; of rough wood upon rough wood one-half of the weight; of soft wood upon hard, or hard upon soft, one-fifth of the weight; of polished steel upon polished steel or pewter, one-quarter of the weight; of polished steel upon copper one-fifth; and of polished steel upon brass, one-sixth of the weight. Coulomb made numerous experiments upon friction, and, by employing large bodies and ponderous weights, and conducting his experiments on a large scale, corrected several errors, which necessarily arose from the limited experiments of preceding writers. He brought to light many new and striking phenomena, and confirmed others, which were previously but partially established. 1. The friction of homogeneous bodies, or bodies of the same kind, moving upon each other, is generally supposed to be greater than that of heterogeneous bodies; but Coulomb showed that there are exceptions to this rule. 2. It was generally supposed that, in the case of wood, the friction is greatest when the bodies are drawn contrary to the course of their fibres; but Coulomb showed, that the friction in this case is sometimes the smallest. 3. The longer the rubbing surfaces remain in contact, the greater is their friction. 4. Friction is, in general, proportional to the force with which the rubbing surfaces are pressed together, and is commonly equal to between one-half and one-quarter of that force. 5. Friction is not generally increased by augmenting the rubbing surfaces. 6. Friction is not increased by an increase of velocity; at least it is not generally so; and, in some cases, even decreases with an increase of celerity. 7. The friction of cylinders, rolling upon a horizontal plane, is in the direct ratio of their weights, and in the inverse ratio of their diameters. An easy method of experimenting on the friction of surfaces, is, to place a plank with its upper surface level, and on this a thin block of the matter to be tried, with a cord fixed to it, which block may be loaded with different weights; and a spring steelyard attached to the other end of the cord, to draw it along by, will show the force necessary to produce motion. It appears from experiments, that the friction of different combinations of matter differs very considerably, and that an immense quantity of power may be lost in a machine by using those substances for the rubbing parts which have great friction. In a combination where gun-metal moves against steel, the same weight may be moved with a force of 15½ pounds, which it would require 22 pounds to move when cast-iron moves against steel.

The most efficacious contrivances for diminishing friction, are *friction wheels*, by means of which, that species of friction which arises from one body being dragged over another, is changed into that which arises from one body rolling upon another. The application of friction-wheels is shown in *Figs*. 6. and 7. of *Plate XXV*. *Fig*. 6. represents M. Gottlieb's anti-attrition axle-tree, which consists of a steel roller R about five inches long, turning in a groove cut in the lower part of the axle-tree C, which works on the nave A B. *Fig*. 7. shows the method of applying friction rollers used by Mr. Gamett. A space between the axle E, and the nave of the wheel ABDC, is filled with friction-rollers, R, R, R, &c., whose axes are inserted in circles of brass, which are rivetted together by means of bolts which pass between the rollers, in order to keep them separate and parallel. When the moving force is not exerted in a perpendicular direction, but obliquely as in undershot wheels, the gudgeon will press with greater force on one part of the socket than on any other part. This point will evidently be on the side of the bush opposite to that where the power is applied; and its distance from the lowest point of the socket, which is supposed circular and concentric with the gudgeon, being called x, we shall have Tang. $x = \frac{H}{V}$, that is, the tangent of the arch contained between the point of greatest pressure and the lowest point of the bush, is equal to the sum of all the horizontal forces, divided by the sum of all the vertical forces and the weight of the wheel, H representing the former, and V the latter quantities. The point of greatest pressure being thus determined, the gudgeon must be supported at that part by the largest friction wheel, in order to equalize the friction upon their axles. Friction wheels seem to have been first recommended by Casatus. They were afterwards mentioned by Sturmius and Wolfius, but were not in actual use till Sully applied them to clocks in 1716, and Mondran to cranes in 1725. They remained, however, almost unnoticed till the celebrated Euler explained their nature and advantages in his memoirs on Friction. Another method of diminishing friction, is to apply the impelling power (when it can be done) in such a way as to act either in opposition to, or obliquely to the force of gravity. If we suppose, for example, that the weight of a wheel, whose iron gudgeons move in bushes of brass, is 100 pounds, then the friction arising from both its gudgeons will be equivalent to 25 pounds. If we suppose also that a force equal to 40 pounds is employed to impel the wheel, and acts in the direction of gravity, as in the cases of overshot wheels, the pressure of the gudgeons upon their supports will then be 140 pounds, and the friction 35 pounds. But if the force of 40 pounds could be applied in such a manner as to act in direct opposition to the wheel's weight, the pressure of the gudgeons upon their supports would be 100 — 40, or 60 pounds, and the friction only 15 pounds. It is impossible indeed to make the moving force act in direct opposition to the gravity of the wheel, in the case of water-mills; and it is often impracticable for the engineer to apply the impelling power but in a given way: but there are many cases in which the moving force may be so exerted, as at least not to increase the friction which arises from the wheel's weight. A contrivance for diminishing friction by rendering an axis of rotation unnecessary, is shown in *Plate XXV. Fig.* 9. where A is a cylindrical wheel without an axis of rotation, but turned by the rope *rr*, passing round a groove in its circumference. The wheel A is supported by the three wheels, or rollers, *w*, *w*, *w*, which have a groove hollowed out upon their circumference. Another method of diminishing friction, proposed by M. Gaston de Thiville, is shown in *Plate XXV. Fig.* 8. The wheel R has two hollow cylinders, *m*, *n*, fixed to its axle AB. These cylinders are made to float in boxes filled with water, in such a manner that the gudgeons pass through the boxes of water, so as to be water tight without preventing their rotation. The weight of the wheel is thus supported upon the floating cylinders, and it is kept in its place by the gudgeons *x*, *y*. As it appears from the experiments of Coulomb, that the least friction is generated when polished iron moves upon brass, the gudgeons and pivots of wheels, and the axles of friction rollers, should all be made of polished iron; and the bushes in which these gudgeons move, and the friction wheels, should be formed of polished brass. In small and delicate machinery, the cups, or planes, which support pivots, or upon which knife-edges rest, as in balances and pendulums, should be made of garnet in preference to any other substance. When every mechanical contrivance has been adopted for diminishing the obstruction which arises from the attrition of the communicating parts, it may be still farther removed by the judicious application of unguents. The most proper for this purpose are swine's grease and tallow, when the surfaces are made of wood, and oil when they are of metal. When the force with which the surfaces are pressed together is very great, tallow will diminish the friction more than swine's grease. When the wooden surfaces are very small, unguents will lessen their friction a little, but it will be greatly diminished if wood moves upon metal greased with tallow. If the velocities, however, are increased, or the unguent not often enough renewed, in both these cases, but particularly in the last, the unguent will be more injurious than useful. The best mode of applying it, is to cover the rubbing surfaces with as thin a stratum as possible, for the friction will then be a constant quantity, and will not be increased by an augmentation of velocity. In small works of wood, the interposition of the powder of black lead has been found very useful in relieving the motion. The ropes of pulleys should be rubbed with tallow, and whenever the screw is used, the square threads should be preferred. In order to apply unguents to the communicating parts of machines, various contrivances have been adopted. The spindles of trundles have been made hollow, to contain oil, so that when they had a horizontal position, they allowed it to drop from small apertures upon the wheel below, by which they were driven.

The resistance called *friction* performs important offices in nature and in works of art. Friction destroys, but never generates motion. Were there no friction, all bodies on the surface of the earth would be clashing against one another: rivers would dash with unbounded velocity, and we should see little besides collision and motion. At present, whenever a body acquires a great velocity, it soon loses it by friction against the surface of the earth; the friction of water against the surfaces it runs over soon reduces the rapid torrent to a gentle stream; the fury of the tempest is lessened by the friction of the air on the face of the earth; and the violence of the ocean is subdued by the attrition of its own waters. Its offices in works of art are equally important. Our garments owe their strength to friction; and the strength of ropes, sails, and various other things, depends on the same cause; for they are made of short fibres, pressed together by twisting: and this pressure causes a sufficient degree of friction to prevent the fibres sliding one upon another. Without friction, it would be impossible to make a rope of the fibres of hemp, or a sheet of the fibres of flax; neither could the short fibres of cotton have ever been made into such an infinite variety of forms as they have received from the hands of ingenious workmen. Wool also has been converted into a thousand textures for comfort or for luxury; and all these are constituted of fibres united by friction. In fine, if friction retards the motion of machines, and consumes a large quantity of moving power, we have a full compensation in the numerous and important benefits which it insures to us.

FRICTION, in medicine and surgery. The act of rubbing the surface of the body, whether with the hand only, with the flesh-brush, flannel, or other substances, or with oils, ointments, or other medicinal matters, with a view to the preservation of health, or to the removal of particular diseases. The wholesome effects of friction are well illustrated by the advantages of currying horses. Friction is an efficacious remedy in several conditions of disease; particularly in chronic rheumatisms of long standing; in muscular contractions, succeeding to rheumatism, &c., and connected often with effusions of lymph; in some states of paralysis; in certain indolent tumours, &c. In these cases a variety of unguents and liniments is recommended; but the friction itself is the principal source of relief.

FRINGE-TREE,—botanically *Chionanthus.* A genus of ornamental shrubs and trees, of the olive-tree tribe. The Virginian fringe-tree, *Chionanthus Virginica*, is a native of various parts of North America, and was introduced about 110 years ago to Britain. It is often called the snowdrop-tree; and it carries snow-white flowers in bunches over almost every part of its surface, and in consequence gave the name Chionanthus or "snow-flower" to the whole genus. It is exceedingly shy of either growing or blooming in Britain; but in countries and climes which it loves, it is one of the most beautiful of plants. Its stem is rough and dark brown, and attains in its native country a height of 30 or 40 feet; its leaves are large, laurel-shaped, broad, roundish, and of a fine deep green on their upper surface; and its flowers bloom from May till July, and so profusely cover the tree as to make it look at a little distance as if mantled with snow.—Two other species, neither of them above one-third of the height of the preceding, have been introduced to Britain, the one from North America, and the other from the East Indies; and 5 or 6 additional species have been scientifically described.

FRITILLARY,—botanically *Fritillaria.* A genus of hardy, bulbous-rooted, splendidly-flowering plants, of the tulip family. The most gorgeous species is *F. imperialis*, and has been described in the article CROWN IMPERIAL. The common, or guinea-fowl, or snake's-head, or chequered daffodil species, *F. meleagris*, is a native of the moist pastures of Britain, particularly of the south of England. Its root has a small, compact tuber, of about the size of a hazel-nut; its stem is usually about 12 or 14 inches high; its leaves are linear; and its flowers are pendulous, and bloom from March till May, and sport themselves into a great variety of colours, with preponderance of red, white, black, and mixtures, but are chiefly purplish and always chequered.—The Persian fritillary, or Persian lily, *F. persica*, was introduced to Britain from Persia before the close of the 16th century, and has long been a favourite in our gardens. Its bulb is large and orbicular; its stem is from 15 inches to 3 feet high; its leaves closely garnish the lower part of the stem, and grow obliquely and twistedly from the sides, and are three inches long and half an inch broad; and its flowers have a brown or dark purple colour, and bloom in April and May, and grow pyramidally or in a loose spike at the top of the stem, but have somewhat wide brims, and are not pendulous.—The early white fritillary, *F. præcox*, was long ago introduced from Continental Europe. Its bulb is compressed and orbicular, and resembles that of the common gladiolus; its stem is about 15 inches high, and forks at the top into two slender, pendulous, flower-stalks; its leaves are few, alternate, and narrow; and its flowers have a prevailingly white colour, but are chequered with purple and white like a chess-board, and they grow singly on the footstalks, and bloom from March till May.—About twenty other species, besides varieties, have been introduced to our gardens; and several additional ones are known. All are propagated from offsets, and are very unfastidious, and may be planted in the same manner as other sturdy bulbs, but at depths and distances proportionate to their size.

FROG, a well-known reptile of the genus Rana. The muzzle of frogs terminates more in a point than that of toads. The nostrils are visible at its summit. The teeth are very small; the eyes large and brilliant, and surrounded with a yellow circle; the ears are placed behind them, and covered by a membrane. The muscles of frogs are considerable in relation to their bulk, and peculiarly elastic, strong, irritable, and sensible to the action of galvanism. Their general sensibility does not appear to be great; they are killed, with difficulty; the heart contracts and dilates a long time after the death of the animal, and even when it has been extracted from the body.

The ordinary mode of progression is by leaps. Frogs feed on the larvæ of aquatic insects, on worms, small mollusca, flies, &c., and always choose a prey which is living and in motion. They are useful in gardens by destroying great quantities of small slugs. These reptiles are usually found during the summer on the ground in humid places, in the grass of meadows, and on the banks of streamlets, into which they continually leap and dive. They swim well and without difficulty by means of their hinder feet, the toes being united by a membrane. At the close of warm rains in the fine season, they frequently spread themselves through the country. To this is owing the popular belief in the rains of frogs —a very ancient prejudice. Frogs are distinguished by a peculiar cry, termed *croaking*, particularly during rain and hot weather, in the morning and evening. During the feudal *régime* in France, when the castles were surrounded with water, it was the occupation of the slaves or villains to strike the water of the dikes morning and evening to prevent the frogs from disturbing the repose of their masters. Even up to the period of the revolution, this custom existed in many places. As soon as the summer is over, and the weather begins to be a little cold, the frogs lose their natural voracity, and cease eating. As the cold increases, they sink into the mud of deep waters, the holes of fountains, and sometimes even into ground not covered by water, and pass the winter in profound lethargy. The female lays annually from six to twelve hundred eggs; and frogs can live a great number of years if they escape their enemies,—serpents, pikes, vultures, storks, &c.,—which destroy immense quantities of them. In France they are much used for food, and in Germany also. The continental physicians employ their flesh, variously prepared, in the treatment of a number of diseases.

There are numerous species of this animal. The Green frog, *Rana esculenta*, is about two or three inches long, without reckoning the hinder feet. It abounds in stagnant waters on the continent of Europe and in Asia, but is less common in England than the *Rana temporaria*. It seldom comes to land, and never removes from the banks of streams, ponds, or lakes. The *Rana temporaria*, or common frog of England, is tolerably abundant throughout Europe, prefers wooded and mountainous situations, and frequents meadows and gardens during fine weather. It is generally found on land in summer. At the approach of winter, it retires into fountains and ponds of pure water, but does not bury itself in the mud at the bottom. The *Rana clamitans*, found in Carolina, of an obscure colour, is the liveliest of all known frogs. It croaks continually, and never removes far from the shore. The *Rana pipiens*,—called in the U. States the *bull frog*,—is the largest species of this genus, being three or four inches broad and six or eight in length, without including the feet; with the limbs extended, it measures about eighteen inches. It inhabits North America, particularly the southern part of the U. States. Its cry is very deep and hoarse. It is very fond of young ducks and goslings, which it swallows whole. On level ground, it makes leaps of from 6 to 8 feet. The *Rana grunniens*, if distinct from the preceding species, is fully as large. It is found in the West Indies, and is said to be able to clear, with a leap, a wall five feet high. The *Rana paradoxa* is found at Surinam, and in other countries of South America. As the adult animal is less than the tadpole, in consequence of the loss of an enormous tail, and of some envelopments of the body, some observers formerly supposed that the animal passed from the frog to the tadpole state, and was subsequently transformed into a fish; this error, however, is completely refuted.

FROG OF A HORSE. See Foot.

FROGBIT,—botanically *Hydrocharis*. An indigenous aquatic plant, forming the type of the natural order Hydrocharideæ. This order consists of floating, white-flowered, curious plants, and is distributed throughout various parts of the world. Two of its most remarkable genera are vallisneria, possessing habits which very singularly and strikingly evince the wisdom of the Creator,—and stratiotes, distinguished for its majestic and elegant appearance. The frogbit plant constitutes a genus of itself, and takes for its specific name *morsus ranæ*. It floats on the water of ditches, ponds, and still streams in various parts of England, but is of rare occurrence in Scotland. It is a fine ornament of the close scenes of the villa or of home-grounds when grown in cisterns, and is easily propagated from either seeds or stolons. Its root consists of many filiform fibres; its leaves are heart-shaped or kidney-shaped, not two inches broad, and purplish below; and its flowers are numerous, exceedingly delicate, and prevailingly white with a yellow centre, and bloom in June and July.

FROG-ORCHIS,—botanically *Gymnadenia Viridis*. A very beautiful, tuberous-rooted, indigenous plant, of the orchis family. It inhabits the pastures of several parts of Britain, has a height of 9 or 10 inches, and carries a greenish flower in June and July. Linnæus ranked it as a Satyrium.

FROND. A leaf-like organ of plants, combining the properties of leaf, leaf-stalk, and branch or stipe. The apparent leaves of ferns, palms, and cycadeæ are fronds which combine the properties of branch and leaf; and the apparent leaves of arbor vitæ and some similar conifers are fronds which combine the properties of stipe and leaf. The constituent parts of the former class of fronds continue to adhere to one another after their fall and during their decay.

FRONDESCENCE. The natural development or growth of leaves or fronds.

FRONTAL BONES. The bones of the forehead of man and quadrupeds and other vertebrated animals. The frontal sinuses in horses, cattle, and sheep, are numerous little vacuities or cells between the exterior and the interior plates of the frontal bones; and these are lined by a prolongation of the membrane of the nose, and are frequently the seat of annoying and inflammatory diseases. The bot of the sheep matures its larvæ within these sinuses. See the article Bots. The loathsome and infectious disease of glanders in the horse, has intimate connexion with them. See the article Glanders. A nasal gleet in cattle is sometimes occasioned by inflammation of the membrane of the sinuses, or by the lodgement within them of some grubs or worms; and it may then assume a very serious character, and require to be attacked by opening the skull at the root of the horn, or by entirely cutting the horn away, in order to draw off the purulent matter which may have accumulated in the cavities. But in every instance of such extreme remedy, the orifice ought to be speedily closed, so as to exclude the air from access to the sinuses. Youatt says that upwards of a pint of pus has sometimes escaped.

FROST. The name we give to that state of our atmosphere in which water is changed into ice. See FREEZING. The degree of temperature at which this takes place, is called the *freezing point*. See FREEZING POINT. The cold air draws from water the portion of caloric which is necessary for its existence in a fluid state. The power of frost is immense; a freezing liquid will burst the strongest vessels in which it is enclosed. Organic bodies do not suffer so much from it, and many are entirely unhurt by it. Severe frosts are not so injurious to plants, after dry weather, as when they follow immediately after rain or a thaw. The cause of this probably is, that in damp weather, even in winter, the tender vessels of plants are filled with sap, which, expanding into ice at the time of the frost, breaks them, and thus injures their whole internal organization. From the same cause, the strongest oaks split in a severe frost; which is also dangerous, and sometimes fatal to men and animals. It appears wholly to destroy the irritability of the bodily frame, and to rob it of its internal heat. A person feels an irresistible inclination to sleep; he yields, though against his will, and, while lost in insensibility, his limbs begin to stiffen. If a man thus asleep be brought into a warm room, the sudden passage from cold to warmth causes his death; but if he be rubbed in the snow, he may often recover. The same is the case with regard to the frozen limbs of men and animals, which can only be saved by being gradually thawed, especially in snow. Frost is also very injurious to certain kinds of food. All watery fruits are deprived by frost of their pleasant taste and their nourishing properties, and soon grow rotten after being thawed. Even meat, which appears to be preserved from tainting by the frost, corrupts soon after thawing. Liquids, as beer, for instance, lose their good taste. Violent winds always diminish the coldness of the air. Many fluids expand by frost, as water, which expands about one tenth part, for which reason ice floats in water; but others, again, contract, as quicksilver, and thence frozen quicksilver sinks in the fluid metal. Frost, being produced by contact with the atmosphere, naturally proceeds from the external parts of bodies inwards; so, the longer a frost is continued, the thicker the ice becomes upon the water in ponds, and the deeper into the earth is the ground frozen. In about 16 or 17 days' frost, Mr. Boyle found it had penetrated 14 inches into the ground. At Moscow, in a hard season, the frost will penetrate two feet deep into the ground; and captain James found it penetrated 10 feet deep in Charlton island; and the water in the same island was frozen to the depth of six feet. Scheffer assures us, that, in Sweden, the frost pierces two cubits, or Swedish ells, into the earth, and turns what moisture is found there into a whitish substance, like ice, and penetrates standing water to three ells or more. The same author also mentions sudden cracks or rifts in the ice of the lakes of Sweden, nine or ten feet deep, and many leagues long, the rupture being made with a noise not less loud than if many guns were discharged together. By such means, however, the fishes are furnished with air, so that they are rarely found dead. The natural history of frosts furnishes very extraordinary results. The trees are often scorched and burnt up, as with the most excessive heat, in consequence of the separation of water from the air, which is therefore very drying. In the great frost in 1683, the trunks of oak, ash, walnut, &c., were miserably split and cleft, so that they might be seen through, and the cracks were often attended with dreadful noises, like the explosion of fire-arms. The close of the year 1708, and the beginning of 1709, were remarkable, throughout the greatest part of Europe, for a severe frost. Doctor Derham says it was the greatest in degree, if not the most universal, in the memory of man; extending through most parts of Europe, though scarcely felt in Scotland or Ireland. In very cold countries, meat may be preserved by the frost six or seven months, and proves tolerably good eating. In that climate, the frost seems never out of the ground, it having been found hard frozen in the two summer months. Brandy and spirit, set out in the open air, freeze to solid ice in three or four hours. Lakes and standing waters, not above 10 or 12 feet deep, are frozen to the ground in winter, and all their fish perish. But in rivers, where the current is strong, the ice does not reach so deep, and the fish are preserved. Hoar frost is the dew frozen or congealed early in cold mornings; chiefly in autumn.

FRUIT. The final epitome or reproductive organizement of many kinds of plants. But the botanical meaning of a fruit, and the horticultural one, are widely different.

A fruit, in the botanical sense, is any kind of pericarp which encloses one or more seeds; and it may be either a capsule, a berry, a drupe, a pome, a silique, a legume, a cone, or a catkin. A capsule is a membranaceous pericarp which, when ripe, separates into valves; a berry is a soft and pulpy pericarp, enclosing naked seeds; a drupe is a soft and pulpy pericarp, enclosing a shell-enveloped seed or what is popularly called a stone; a pome is a fleshy pericarp, enclosing one or more capsule-enveloped seeds; a silique and a legume are pericarps of the kind popularly called pods, but differing from each other in form and structure; and a cone and a catkin are pericarps of indurated scales, the former of pines and all other coniferous trees, and the latter of hazels, willows, poplars, and all other amentaceous trees. Familiar examples of a capsule are the seeds of cowslips and polyanthuses; of a berry, currants and grapes; of a drupe, plums and cherries; of a pome, apples and pears; of a silique, the seeds of Shepherd's Purse; of a legume, beans and pease; of a cone, fir-tops and junipers; and of a catkin, the cat's-tails of willows and poplars. As to shape, fruits may thus be orbicular, elongated, multangular, or diversified, but are principally spherical or elliptical; as to size, they are exceedingly varied, but not at all proportioned to the plants which bear them; and as to appearance, they are, in numerous instances, either as elegant as some of our finely ornamental flowers, or eminently curious and replete with displays of the Creator's wisdom and beneficence. The structure and uses of their principal component parts will be noticed in the articles PERICARP and SEED.

A fruit, in the horticultural sense, is any pulpy or fleshy accompaniment of seed, of an agreeably esculent nature, and fit to be used as a dessert. The earliest fruits mentioned in history, are the grape, the apple, and the fig, the former being cultivated about the time of the Deluge. The almond is mentioned repeatedly in the sacred records, nearly 4,000 years ago; and Theophrastus, who lived about 300 years before the Christian era, remarks that it was the only tree in Greece that produced blossoms before the leaves; hence we may safely infer that the peach was then unknown. The fact that the Jewish history nowhere speaks of the peach, indicates that it was not a native of Persia, a country long inhabited by that people. It was known to the Romans at the height of their power, and the nectarine was spoken of by Columella and by Pliny, as an admired fruit of their time. The apple and pear were well-known in the days of Pliny, who speaks of twenty-two varieties of the former, and thirty-six of the latter. The cherry, a native of Pontus and some parts of Europe, was introduced among the Romans at the time of the Mithridatic war. The plum was known both to the Greeks and Romans; and Pliny, who sometimes dealt in the marvellous when writing on fruits, asserts that they were grafted upon apple-stocks, producing what were called apple-plums, and upon almond-stocks, yielding both fruits, the stone being like that of an almond. And Virgil, with equal absurdity, speaks of grafting apples on planes, of adorning the wild ash with the blossoms of the pear, and represents swine as crunching acorns under elms; nor is it very long since a few equally singular notions were held by some moderns.

The cultivation of fruit in Britain began to receive attention with other rural improvements. The earliest British writer on this subject was Richard Arnold, who published a chapter in his 'Chronicles' in 1502, 'On the crafte of graftynge and plantynge and alterynge of fruits, as well in colour as in taste.' He was succeeded about 1538 by Tusser; in 1597 by Gerard; in 1629 by Parkinson; in 1658 by Evelyn; in 1724 by Miller; in 1791 by Forsyth; soon after which the great improvements introduced by the late president Knight, and followed by Lindley, Thompson, and others, formed a new era in the cultivation of fruits. The gradual progress of the art is indicated in part by the number of varieties distinctly named or described by the various authors already mentioned. "Apples of all sorts," are mentioned by Tusser; seven sorts by Gerard; Parkinson enumerates sixty-seven; Hartlib in 1650 alluded to one cultivator who possessed two hundred, and believed there were not less than five hundred; Ray in 1688 says there were seventy-eight cultivated in the London nurseries; Forsyth in 1806 describes a hundred and ninety-six kinds; George Lindley, in 1831, minutely and accurately described two hundred and fourteen; while the Fruit-catalogue of the London Horticultural society gives a list of fourteen hundred varieties, collected and cultivated by that society, three fourths of which were found to be either the same fruit under different names, or else unworthy of cultivation. The same remark will apply, at least in part, to the many hundreds advertised for sale in different nurseries in the United States.—A similar progress, less in degree, is indicated in the cultivation of the pear. Tusser speaks "of all sorts;" Parkinson enumerates sixty-four varieties; Miller, eighty; and Lindley describes one hundred and sixty-two.—Most of these writers also mention numerous varieties of the cherry and plum.—Gerard describes the early, and the white, red, and yellow peaches, and says there were many others; Parkinson enumerates twenty-one; Miller thirty-one; Lindley describes sixty; and in North America—a country more favourable to the peach than England—there are probably not less than two or three hundred known and named varieties.—Eminent advantages have resulted from the application of scientific principles, by Lindley, Knight and others, in the cultivation of fruit, and in the propagation of improved varieties. Several hundred new pears, some of them of the finest quality, were obtained by Van Mons of Belgium, by a successive selection of improved seedlings; and Knight in England has produced some of the finest varieties of the cherry, plum, and apple, by a cross fertilization of old sorts. One of the greatest difficulties yet remaining, is the confusion in the names of varieties. The very slight shades of difference in many; the impossibility of accurately defining these shades in written descriptions; and the changes produced in them by soil, situation, climate, and culture, have largely contributed to this difficulty. It has also been increased by looseness, carelessness, and want of precision in descriptions, and especially the almost total neglect of a classification of flavours, usually the most unvarying and great decisive point of distinction in varieties. "Some individuals," says Loudon, "who have cultivated, fruited, or studied extensive collections of apples, pears or plums, may know at sight a considerable number of varieties; but in general, very few sorts are known by one individual; and in the great majority of cases a gentleman gardener can speak with confidence regarding those sorts only which are under his care. The reason of this is that the shades which distinguish varieties are so fleeting as not to be retained in memory, or only retained to a very limited extent. An apple may be distinguished from twenty other apples all very much alike, when the whole twenty are placed together before the eye; but any one of the twenty, taken apart, and delineated and described, however perfectly, will hardly present any marks sufficiently distinctive to be remembered, and by which it may be recognised with any degree of certainty." The great number of names often given to one fruit, either from ignorance or to promote its sale, have added to the confusion. The celebrated Virgalieu pear has thirty different names; the Brown Beurré, fourteen; several others have nearly an equal number. The confusion resulting also from various applications of these different names by different cultivators, may be easily imagined. The varieties of the peach which Lindley describes as Grosse Mignonne, Neil's Early Purple, Pourpree Hative, Royal Kensington, and Superb Royal, are all described as a single variety by M'Intosh, under the name Grosse Mignonne, to which he adds twenty-seven synonyms.—The labours of the London Horticultural society have contributed much towards removing the bewildering confusion into which the numerous fruits and their names were thrown. Large collections were made from different countries; and by a careful and minute examination for several successive years, innumerable mistakes were corrected. The subject is also receiving much attention in various parts of the United States. The indispensable necessity of a more thorough examination of fruits by those who propagate them for sale, is more appreciated and becoming reduced to practice. Several extensive collections of American and European fruits have recently been made or greatly augmented, for the purpose of a more thorough examination, comparison, and selection of varieties. That every difficulty may be removed, and every disputed question settled, is not to be expected; but they will of course be diminished in proportion to the extent and accuracy of these labours.

Most fruits, particularly berries and pomes, contain large quantities of acid, sugar, and mucilage, considerable quantities of lignin, and very perceptible quantities of some aromatic compounds of carbon and hydrogen; but they very widely differ from one another in both the kinds and combinations of their proximate principles, and each species undergoes great changes of constitution during the process of ripening, and is subject to very wide deviations from its normal constitution under the influence of weather, climate, and the circumstances of culture. The sugar of all is grape sugar; and the acids in most are the citric, the malic, the tartaric, the oxalic, or a combination of some two or more of these. Fruits ripen by absorbing oxygen and evolving carbonic acid,—a process chemically opposite to that performed by leaves, and strictly analogous to that of animal respiration; they generally conduct this process with a vigour and amplitude proportioned to the play of sunshine which they enjoy; and during the whole of its progress, they acquire grape sugar either from the transmutation of a portion of their acid or from other sources. Their ripening, therefore, comprises a change from a sour to a sweet condition; and this change is always more complete in sunny than in cloudy seasons. When tartaric acid is present, three equivalents of it combined with two equivalents of water and six equivalents of absorbed oxygen, will produce one equivalent of grape sugar and twelve equivalents of evolved carbonic acid; and when other acids, or lignin, or other proximate carbonaceous principles pass into grape sugar, they may, with equal ease, be understood to resolve themselves by proportional recombinations of carbon, oxygen, and hydrogen. Some are capable of ripening after separation from the tree; and these lose lignin, gum, and water, during the process, and may be supposed to acquire their grape sugar principally at the expense of their lignin;—but others can ripen only when on the tree; and these probably acquire their sugar in large quantities from various sources, and in many instances pass from a comparatively sour to a comparatively sweet taste vastly less by the loss of acid than by the acquisition of an overwhelming proportion of sugar.

The chemical nature of the process of ripening suggests how that process may be either accelerated or retarded, how the fresh state of delicate fruits may be prolonged, and how the air operates on mature fruits to make them decay and rot. The grand art of preserving freshness is to pull the fruit before they are quite ripe, and close them up from the pressure of free or atmospheric oxygen. In some cases, simple immersion in carbonic acid is sufficient; and in all, the laying of a paste of lime, copperas, and water, at the bottom of jars to absorb oxygen, the placing of the fruit in the interior of the jars but out of contact with the paste, and the thorough covering or cementing of the jars so as to exclude the air from without, are eminently successful. In this latter way, peaches, apricots, prunes, and several kinds of plums will keep quite fresh during from 20 to 30 days; and pears and apples will keep quite fresh for three months. The process of decay, like that of ripening, absorbs oxygen and evolves carbonic acid, but, instead of adding to the sugar, it destroys and dissipates all which previously existed. "During decay, the lignin becomes brown; and its decomposition, as well as that of the gum and the water, occasions the formation of comparatively large volumes of carbonic acid gas. The sugar also becomes decomposed at this time; and to its disappearance, in a great measure, is to be attributed the peculiar taste of decayed or rotten fruits. The sugar during its decomposition, likewise, doubtless gives rise to the formation of carbonic acid,—a great part of which, combining with the hydrogen evolved from the decomposing water, forms carburetted hydrogen, which is the main source of that ill or miasmatic taste and smell, so characteristic of vegetable putridity."

FRUITFULNESS. The power of abundant production. This power exists in some organic beings in an incredible degree: in a poppy, 32,000 seeds have been counted. The elm produces annually 100,000 seeds. How numerous is the annual production of seeds from fruit-trees, &c.! As each of these seeds is capable of becoming an individual of the same sort, if each of them grew up, the whole surface of the earth would soon be covered with trees. In the lower classes of animals, the fruitfulness is no less great: the queen-bee lays every year 5,000 or 6,000 eggs. The vast swarms of locusts, which sometimes lay waste immense tracts of cultivated country in Asia and Africa, and the caterpillars which are often so numerous in our own land, justify us in attributing to them the greatest fruitfulness.—The smallest herring has 10,000 eggs. A carp which weighs only half-a-pound, has 100,000, a larger one, 262,280; a perch, 324,640. The spawn of the sturgeon is calculated to contain 7,653,200 eggs. In the cod-fish, the number of eggs is reckoned at 9,344,000. In the higher classes of animals, there is less of fruitfulness; yet even in men, it is greater than the mortality. In the last case, however, much depends upon climate, season, food, habits, manners, temperament, &c.

The following hints as to the causes of fruitfulness amongst fruit-bearing trees, will be useful to the fruit-culturist. Whatever tends to a rapid circulation of the sap, and to increase the growth of a tree, causes also the formation of leaf buds instead of flower buds. On the contrary, whatever tends to an accumulation of sap in any part, or to retard its circulation, induces the production of flower instead of leaf buds. When trees are young, and the bark and wood soft and flexible, the sap flows freely and without check; hence, leaf buds and the vigorous growth of branches are the result; but as trees become older, and the bark and other parts more rigid, they appear to offer more resistance to a free circulation, and hence the production of flowers and consequent fruitfulness of the tree. This principle enables us to apply artificial means at pleasure for the promotion of the same objects. When trees are young and small, a rapid growth and the attainment of size is desirable, which is given by enriching the ground, and thorough and constant cultivation. A neglect of these operations would check free growth and circulation, and cause the tree to bear. This would, however, be at the expense of the future vigour and size of the tree, and of the size and excellence of the fruit. Indeed, it often happens, that with the best treatment, trees will bear as young as their ultimate success requires. There are, however, some varieties, which, in rich soil, continue growing a long time in an unproductive state. Fruitfulness is caused in various ways. 1. By neglecting cultivation, or suffering grass to grow under them, which diminishes their growth. 2. Pruning the roots beneath the surface, by cutting off a part of the larger ones, causing the same result. 3. Ringing the branches, or removing a small ring of bark round them, which prevents the fluids from flowing back or downwards, and consequently induces their accumulation, to the formation of flower buds. 4. Bending the branches downwards, causing a similar accumulation with the like result. 5. Grafting on dissimilar stocks, which prevents a free flow of sap and juices at the point of junction.

1. Suffering grass to grow among trees, though beneficial in some very rare instances, is not on the whole advisable. The loss in the quality of the fruit is too great, and is not balanced by the advantages. The complaint of unfruitfulness has been more frequently applied to the pear; but a selection of many new sorts, originated in the present century, and which bear while yet very young, entirely obviates the difficulty.

2. *Pruning the roots*, is of recent invention, and in some instances has proved eminently successful.

3. *Ringing the branches* is effected by taking out a narrow ring of bark, extending round the branch. By obstructing the downward descent of the juices, and by their accumulation above the ring, it not only causes fruitfulness, but frequently alters the appearance and quality of the fruit. In some cases, it has doubled the size; in others it has brightened the colours. In the Court Pendu apple, the colours are changed from green and dull red, to brilliant yellow and scarlet. But Lindley says, "If performed extensively upon a tree, it is apt, if not to kill it, to render it incurably unhealthy; for if the rings are not sufficiently wide to cut off all communication between the upper and lower lips of the wound, they produce little effect, and if they are, they are difficult to heal. For these reasons, the operation is but little employed."

4. *Bending the branches downwards*, by changing their natural position, as well as causing a partial obstruction where bent, is said eminently to promote their fruitfulness.

In all these modes, it must be remembered that the desired result will not be produced at once, as the first year is occupied in the formation of flower buds; and the next in their growth into fruit. This delay, however, will not take place, where the difficulty consists merely in the fruit not setting, the buds being already formed.

5. *The influence of the stock*, when it differs in nature from the graft, is often of importance. The more widely they differ, the greater will be the effect. Thus, when pears grow upon pears, the effect is the same as when not grafted at all. But pears on quinces are attended with an increase of fertility. Hence the quince stock is adopted for some otherwise sterile varieties. Such trees, however, are short lived.

These artificial modes of inducing fruitfulness are not to be recommended for general practice. It is true that trees will yield fruit sooner; but heavy crops from young trees are not desirable, as stunting the tree, and inferior fruit are often the consequence. Let them grow freely for a few years, and the amount ultimately obtained from them will be the greater. Indeed, the period of fruitfulness is often hastened by cultivation, and retarded by neglect. Except for the sake of experiment, the preceding modes are not to be applied until trees are large, when most varieties will bear sufficiently without them.

When fruit is thick upon the branches, both size and flavour are diminished. Many kinds are rendered nearly worthless by overbearing. It is often observed that early apples and peaches, remaining last on the tree, are much more delicious than the earlier portions which ripened on crowded limbs. With some varieties, the effect of productiveness is so great as wholly to alter the character. A tree of the Heath cling, before unknown to the person who raised it, bore the first year a very abundant crop; and the fruit, which had been recommended as of great size and excellence, was small, green, with only a disagreeable, bitter taste. In the warmer and longer summer of the following year, the fruit, which had been thinned by the frost, was three inches in diameter, very handsome, and of sweet and excellent flavour. The importance of understanding these influences, before deciding on the quality of a new fruit, is hence at once evident. The advantages of pruning are to be ascribed in part to the same cause. —*Thomas's Fruit Culturist.*

FRUIT-GARDEN. See Garden.

FRUIT-STORING. Fruits in general should be gathered in the middle part of a dry day; not in the morning, before the dew is evaporated, nor in the evening when it begins to be deposited. Plums readily part from the twigs when ripe: they should not be much handled, as the bloom is apt to be rubbed off. Apricots may be accounted ready when the side next the sun feels a little soft upon gentle pressure with the finger. They adhere firmly to the tree, and would over-ripen on it. Peaches and nectarines, if moved upwards, and allowed to descend with a slight jerk, will separate if ready; and they may be received into a tin cup or funnel lined with velvet, so as to avoid touching with the fingers or bruising. If this funnel have a handle two or three feet long, the fruit may be gathered with it from any low or ordinary wall. The old rule for judging of the ripeness of figs, was to observe if a drop of water was hanging at the end of the fruit; a more certain one is, to notice when the small end becomes of the same colour as the large end. The most transparent grapes are the most ripe. All the berries on a bunch never ripen equally; and it is therefore proper to cut away unripe or decayed berries before presenting the bunches at table. Autumn and winter pears are gathered, when dry, as they successively ripen. The early varieties of apples begin to be useful for the kitchen in the end of June; particularly the codlins and the jenneting; and in July they are fit for the dessert. From this time till October or November, many kinds ripen in succession. The safest rule is to observe when the fruit begins to fall naturally. Another easy mode of ascertaining, is to raise the fruit level with the footstalk; if ripe, it will part readily from the tree: this mode of trial is also applicable to pears. A third criterion is to cut up an apple of the average ripeness of the crop, and examine if its seeds have become brown or blackish; if they remain uncoloured, the fruit is not ready for pulling. Immature fruit never keeps so well as that which nearly approaches maturity; it is more apt to shrivel and lose flavour. Winter-apples are left on the trees till there be danger of frost: they are then gathered on a dry day. In all cases the fruit is plucked with the hand, and great care taken to avoid bruising. For collecting the fruit from half standard and full standard trees, a step-ladder is employed. This ladder may be so contrived that the back shall come away by removing a bolt. The same ladder may thus be used for high wall-trees; but in this case two rods of iron should be made to project six or eight inches from the top, to keep it from resting on the branches of the trees, and injuring them.

Hitt's method of keeping pears may be mentioned. Having prepared a number of earthenware jars, and a quantity of dry moss (different species of hypnum and sphagnum), he placed a layer of moss and of pears alternately till the jar was filled; a plug was then inserted, and sealed around with melted rosin. These jars were sunk in dry sand to the depth of a foot; preferring a deep cellar for keeping them to any fruit-room. Miller's plan may also be noticed. After sweating and wiping, in which operations great care must be taken not to bruise the fruit, the pears are packed in close baskets, having some wheat-straw in the bottom and around the sides to prevent bruising, and a lining of thick soft paper to hinder the musty flavour of the straw from infecting the fruit. Only one kind of fruit is put in each basket, as the process of maturation is more or less rapid in different kinds. A covering of paper and straw is fixed on the top, and the basket is then deposited in a dry room, secure against the access of frost, "and the less air is let into the room, the better the fruit will keep." A label should be attached to each basket, denoting the kind of fruit; for the basket is not to be opened till the fruit be wanted for use. Mr. James Stewart, an experienced gardener at Pinkie, in Scotland, preserved his choice apples and pears in glazed earthenware jars, provided with tops or covers. In the bottom of the jars and between each layer of fruit, he put some pure pit-sand which had been thoroughly dried on a flue. The jars were kept in a dry airy situation, as cool as possible, but secure from frost. A label on the jar indicated the kind of fruit; and when this was wanted, or ought to be used, it was taken from the jars, and placed for some time on the shelves of the fruit-room. The less ripe fruit was sometimes restored to the jars, but with newly-dried sand. In this way he preserved colmarts and other fine French pears till April; the terling till June; and many kinds of apples till July, the skin remaining smooth and plump. Others who also employ earthenware jars, wrap each fruit in paper, and in place of sand use bran. Mr. Ingram at Torry in Scotland, a very intelligent gardener, has succeeded uncommonly well in the management of the fruit-room. For winter pears he finds two apartments requisite, a colder and a warmer; but the former, though cold, must be free of damp. From it the fruit is brought into the warmer room as wanted; and by means of increased temperature, maturation is promoted, and the fruit rendered delicious and mellow. Chaumontels, for example, are placed in close drawers, so near to a stove, that the temperature may constantly be between 60° and 70° Fahr. For most kinds of fruit, however, a temperature equal to 55° is found sufficient. The degree of heat is accurately determined, by keeping small thermometers in several of the fruit drawers, at different distances from the stove. The drawers are about six inches deep, three feet long, and two broad; they are made of hard wood, fir being apt to spoil the flavour of the fruit. They are frequently examined, in order to give air, and to observe the state of the fruit, it being wiped when necessary. Mr. Ingram remarks, that, in Scotland particularly, late pears should have as much of the tree as possible, even although some frost should supervene; such as ripen freely, on the other hand, are plucked rather before they reach maturity.

FRUIT-TREES. Trees and tall shrubs which produce horticultural fruit. The principal kinds in British gardens are apple-trees, pear-trees, plum-trees, cherry-trees, apricot-trees, peach-trees, nectarine-trees, almond-trees, chestnut-trees, walnut-trees, fig-trees, mulberry-trees, medlar-trees, service-trees, quince-trees, vines, orange-plants, and currant-bushes. Some of these are altogether conservatory or greenhouse plants, some require the heat of walls and the warmest soil and exposure, and some are quite hardy, while most of the last may be cultivated either as standards or upon walls or palings. But the methods of treating each are fully noticed in their own respective articles; some general methods of treatment are noticed in the articles BUDDING, GRAFTING, and ESPALIER; and the diseases to which some or most are subject are noticed in the articles APHIS, CANKER, MILDEW, and several others.

FRUNDELE. An old dry measure, equal to two pecks or half a bushel.

FUCHSIA. A genus of ornamental shrubby plants, of the order Onagrariæ. It did not become properly known in Britain till about the year 1825; it did not begin to attract general notice, or to claim a place among the pet plants of florists, till about the year 1830; and it did not excite the general enthusiasm of florists till about the year 1837; and yet it has already become diffused and multiplied and overcultivated till it seems to the rising generation of human beings to be one of the oldest and most common groups of plants in the flower-garden. Two species, the scarlet and the boxthorn-like, were introduced to Britain from Chili before the close of last century; ten species, the slender, the long-stamened, the delicate, the small-flowered, the barked, the arborescent, the conical, the twiggy, the apetalous, and the beautiful, were introduced principally from Chili and Mexico in 1823, 1824, and 1825; three species, the cylindrical-flowered, the wand-branched, and the fulgent, besides several well-marked varieties of previous species, were introduced before the close of 1837; and hybrid varieties beyond computation, and amounting perhaps to many thousands, but in the great majority of instances so inferior as to be thrown away, were produced by British florists during the thirteen years succeeding 1830. All the species are naturally of shrubby form and height; yet most can easily be kept down to the size of under-shrubs; and some, especially the apetalous and the arborescent, can be readily coaxed up to the height and bulk of small trees. Several of the species have a lanky, straggling habit of growth; and few even of the hybrids possess any real elegance of outline. The flowers of all are their grand attraction; and these possess the combined attractions of fine shape, pendulous habit, and brilliant colour of both calyx and corolla, and, in the case of all the superior kinds, are objects of every person's admiration.

The globe fuchsia or globose-flowered fuchsia, *F. globosa*, is singularly elegant, and has given rise to several splendid varieties, and to hundreds of very fine hybrids. It came into notice about 1830; and is regarded by some persons as a British hybrid, by some as a variety of *F. macrostemon*, and by some as a strictly original species. It has a pendulous habit, and may either be kept down to complete dwarfishness or raised to a height of 5 or 6 feet, and has the additional recommendation of being comparatively hardy. Its flowers bloom in great abundance at the axils of all the leaves; they begin to appear in the very earliest stages of its growth after it has fairly formed roots from a cutting; and they have a globe-like form and brilliant crimson colour,—and hang, before they open, like crimson beads with spherical divisions,—and afterwards divide this crimson calyx into four equal sepals, and show their purple corolla like a fold of rich purple velvet, and send down their stamens like long and gorgeous filaments. Several of the varieties of the globosa, particularly *F. g. major*, and *F. g. elegans*, are very decided improvements on the normal plant, and add to its best characteristic properties a larger size, a more rapid growth, and a fuller and more imposing show of bloom. But elegans is regarded by some cultivators as, conjointly with globosa, a variety of F. macrostemon.

Riccarton's fuchsia, *F. Riccartoni*, has a pyramidal outline, and dark foliage, with a brownish hue; and its flowers are not so spherical as those of the globe fuchsia, but hang in oval drops,—and their sepals have a bright coral colour, and expand horizontally,—and their corolla has a velvety texture and a fine dark purple colour, and is entirely exposed by the opening of the calyx, so as to produce a very imposing effect.—*F. formosa elegans*, has a robust habit, is an abundant bloomer, and disputes pre-eminence with both the globe and the Riccarton. Its flowers are perhaps too much elongated before opening; but its red and moderately broad sepals are deeply divided and completely reflex, and exhibit their inside rather than their outside, and admirably disclose the whole of their corolla.

The conquering Venus fuchsia, *F. Venus Victrix*, is the best of a large group of hybrid varieties with pale-coloured calyxes. All these varieties have ever appeared to us unnatural, cadaverous, and as if either scathed by the weather or bleached with chlorine or brimstone; yet they are admired by many persons for the very properties which seem to us faults. The Venus Victrix has a lanky and straggling habit of growth; and, unless repressed and carefully trained when young, it acquires a tall, gawky, scrambling form, bare below, and producing flowers in only the upper portions of its branches. Its calyx is pale, inclining to white, with occasional greenness at the tips, and opens wide enough to show the corolla; and the latter, though at first of a bluish purple colour, becomes paler by exposure, and acquires a wan rosy purple tint.

The cylindrical fuchsia, *F. cylindrica*, is remarkable chiefly for its singularity, but possesses so much of this property as to deserve a place in a collection for the sake of contrast; and it particularly arrests the eye by exhibiting a profusion of very small and brilliant red flowers, each less than one-third of an inch in length. But a variety of it, called *F. cylindrica major*, is greatly preferable, and combines much beauty with its singularity. This has a free habit, and is an intensely prolific bloomer; and its flowers are tubular, scarcely half-an-inch in length, not so large as the flowers of *Russelia juncea*, of as brilliant a scarlet as *Verbena melindris*, with sepals and corolla little developed and both of one colour.—The curious fuchsia, *F. curiosa*, ranks also as a curiosity, yet is not more remarkable than beautiful. It has a singular but elegant habit of both growth and bloom, and carries a great profusion of flowers, and sends out its floral footstalks in a branching and standing manner; and its flowers are tubular, flattened, pendulous, half the length of those of F. fulgens and proportionably slender, with small divisions, and small corolla.

The glowing fuchsia, *F. fulgens*, was introduced from Mexico in 1837, and for several years made a great sensation. Its stem and branches are robust; its leaves are very large; and its flowers are two inches in length, and shaped like the old-fashioned tin-horn of mail-coach guards, and grow at the end of each branch in large bunches, hanging down like massive fashionable tassels, and have their corolla and their tube of one scarlet colour, and the points of the latter tipped with green as if only half-bloomed. This plant is really coarse and inelegant; but the flowers, for a time, enraptured almost every person, and provoked thousands of florists to abandon their taste to the misrule of folly. "The extraordinary form of the flower," remarks a shrewd floral journalist, "made great interest for Fuchsia fulgens; while seeding very freely set everybody raising new ones,—ninty-nine out of every hundred being infinitely worse than the original. Ramping growth, great coarseness, and roughness of the flower, dulness of colour, and total absence of contrast between the corolla and the sepals, distinguished most of them. The more they departed from the original, the worse they were; for the tube shortened so, that the peculiarity which gave the only value it had to the fulgens was lost, while all the coarseness remained; and in many of the new sorts which were huddled out at a considerable price, one of the great faults of the original, the green which would not bloom out of the tips, was yet more conspicuous."

The corymb-flowering fuchsia, *F. corymbiflora*, belongs to the same group as fulgens, but is more robust in habit, coarse in foliage, larger and paler-coloured in flower, and has a brownish hue on its stems and leaves.—*F. exoniensis* is a free grower, and an abundant bloomer, and has a bold and tolerably good habit; its sepals are crimson-coloured, narrow and reflexed; and its corolla is wholly exposed to view, and has at first a deep crimson purple colour, but afterwards fades into a lighter tint.—The Queen Victoria fuchsia is one of the large, coarse, pale varieties, with a bright orange scarlet corolla, and flesh-coloured or almost white sepals, greenish at the tips; and it has a robust habit and rather bold foliage. So very numerous are the varieties and hybrids in vogue at the nurseries, that enumerations of them, like those of dahlias, form matter for separate printed lists.

Fuchsias are easily cultivated; but most require the greenhouse, and even the hardiest, which are able to occupy a place in the shrubbery, need winter protection. All which have bloomed in the house, or are taken into the conservatory, ought to enjoy repose in winter; and the longer and more freely they have bloomed, the longer and deeper should be their winter's sleep. The use of peat for the delicate kinds, improves the vigour of the plants, produces a greater profusion of bloom, and heightens the brilliancy of the colour of the flowers. The shifting of plants from small pots to larger, and from larger to the largest, insures fine, large, and healthy specimens. Kinds which have naturally a strong and erect habit should be frequently stopped and repressed when young, so as to induce a bushiness of foliage and a roundness of shape; and those which have a weak and drooping habit, ought to be trained up with a single stem for a firm longitudinal centre, and to be made to throw out their branches in a lateral manner and with regular, drooping, and graceful pendence.

FUCI. A family of cryptogamic plants, inhabiting, exclusively, the ocean, and generally known by the name of *sea-weed*. They form the family of submerged ALGÆ: see that article. The substance of these vegetables is coriaceous, membranaceous or cartilaginous, hardening when dried, and becoming sometimes brittle. They are generally branched or furnished with fronds, having the form of leaflets, but sometimes simple, or filiform. Their branches are frequently provided with prominent air vesicles, and terminated with pod-like protuberances, some containing interlaced hairs, and others a gelatinous matter enveloping minute globules which are regarded as the seeds; but the origin and functions of these organs are not well understood; and many fuci are destitute of them. Several species present at certain seasons little tufts of articulated hairs, which, on falling, leave little points on the surface of the fronds. Some fuci are transparent, but their colour is usually brown, with a greenish or reddish tinge; and, although varying so much in form, they may be recognised by a certain family resemblance. Their internal structure is entirely cellular, consisting of cells either rounded or more or less elongated; and nutrition takes place by absorption from the whole surface: when partially submerged in water, the portion exposed to the air dries up, while the remainder continues to vegetate. Some species are almost microscopic, while others, inhabiting, especially, the South seas, attain the length of several hundred feet. Their duration is not well ascertained, but usually they are perennial. Very few, if any, are parasitic, though great numbers of polypi and algæ are often attached to them. They are usually fixed by one extremity to rocks, stones, &c., and rocky coasts are frequently covered with them from above low-water mark, as far as the eye can discern the bottom of the ocean. Some, however, are entirely free, and vegetate as well as those which are attached: of this kind is the *Fucus natans*, which has multiplied prodigiously between the tropics, forming floating masses, that cover extensive portions of the ocean, and are so dense as to impede the coarse of ships, at the same time serving as a retreat for immense numbers of fish, shells, worms and crustacea, affording an aliment to these various animals, and even to man, though this latter fact is but little known.

Economical uses of Sea-weeds.—It is observable on most coasts, that sea-weeds, or many species at least, very suddenly disappear from the rocks in the autumn. They do not decay, like land plants, on the spot where they grow; but, losing their hold, are washed away by the tides; and, in the narrow seas at least, generally washed ashore to offer their services to man. Among the Romans they were proverbially useless. In modern times, the *Alga marina* has become useful and valuable in various respects. To the agriculturist it furnishes a most important manure. To the glass-maker and soap-boiler it yields the fixed alkali; and the manufacture of kelp for this purpose was long a valuable source of revenue to the proprietors of the rocky shores of Europe. Of such importance has this manufacture appeared, that in some places attempts were even made, and not without success, to cultivate the fuci. By merely covering sandy bays with large boulder-stones, a crop of fuci has been procured in the course of two or three years,—the sea appearing everywhere to abound with the necessary seeds. From the ashes of the fuci the chemist has of late years derived the very curious elementary substance named *iodine*. Several of them are so rich in saccharine matter, and vegetable mucilage, that on the shores of the northern countries of Europe, and in the Scottish islands, much of the winter-provender of cattle is derived from them; and in Edinburgh these plants have been occasionally given as a useful stimulus to the stomach of milch-cows kept in confinement during the winter. A few of them even afford food to man. What might least of all be expected, two or three of them furnish fuel to the inhabitants of coasts where materials for firing are scarce. Some of the smaller sorts yield various condiments, or afford fresh salads; while others are employed as medicines. From a few of them, substances useful in the arts are procured; and with some of the more delicate and elegant species, ornamental pictures are constructed. While considering the different purposes to which marine plants may thus be applied, it may be agreeable to the reader to see the descriptions of those chiefly employed, and more especially of such useful species as inhabit the British shores.

It is scarcely necessary to say, that every kind of sea-weed may be employed as manure. In point of fact, what is used for this purpose is that which is cast ashore by storms in the winter months, consisting of all sorts, mixed with zoophytes, and all the other rejectamenta of the sea. In many places the value of such manure is duly appreciated; while in others it is unaccountably neglected; not that it is any where entirely despised, but it frequently happens that on one day many tons of drift-ware are cast on a particular shore, and that on the next the whole is swept away. They who would avail themselves of this bounty of the deep, must snatch the moment of its being placed within their power, and muster all hands to drag it at least beyond the reach of the returning tide. It must not be left very long in the heap, nor suffered to run into the putrefactive fermentation; for in this case, sulphuretted hydrogen, and other gases highly important in promoting vegetation, escape rapidly, and in great quantity; leaving a comparatively inert mass. But for details as to the mode of applying this manure to lands, so as best to secure its fertilizing effects, reference may be had to the articles SEAWARE and MANURES.

The nature of kelp, and the mode of its manufacture, are now generally understood. It is a very impure carbonate of soda; containing sulphate and muriate of soda, and also sulphuret of soda, with a portion of charcoal. In Scotland the manufacture used to be carried on chiefly in the months of July and August. The kelp kiln is nothing but a round pit or basin dug in the sand or earth on the beach, and surrounded with a few loose stones. In the morning a fire is kindled in this pit, generally by means of peat or turf. This fire is gradually fed with sea-weed, in such a state of dryness that it will merely burn. In the course of eight or ten hours, the furnace is found to be nearly full of melted matter. Iron rakes are then drawn rapidly backward and forward through the mass in the furnace, in order to compact it, or bring it into an equal state of fusion. It is then allowed to cool, when it is broken in pieces, and carried into a store-house, to remain till shipped. The making of kelp from sea-weed was practised in France and England for more than half a century before the manufacture was introduced into Scotland. Mr. James Fea of Whitehall in Stronsay was the first person in Orkney who, about 1722, exported a cargo of kelp. The fuci which are chiefly cut on our shores for this manufacture, are *Fucus vesiculosus*, *nodosus*, and *serratus*. In some places, *F. loreus* and *F. filum* or *Scytosiphon filum* are employed, but not to a great extent. By means of a boat and long sharp hooks or bills, *F. digitatus* or *Laminaria digitata* is cut in some places; and this species, together with *F. saccharinus*, *bulbosus*, and *esculentus*, or *Laminaria saccharina*, *bulbosa*, and *esculenta*, form much of the drift-ware employed in making of kelp. Some of these are no doubt richer in the alkaline salt than others; but of all of them it may be said, that when dry and fit for burning, they are capable of yielding about one-fifth of their weight in kelp.

Besides the alkali, kelp affords, as already hinted, a peculiar substance named IODINE; see that article. It was discovered in the year 1812, by a manufacturer of saltpetre at Paris named Courtois.

The species reckoned kelp fuci shall now be more particularly described; and as most of them, besides yielding kelp, serve other useful purposes, these shall at the same time be noticed.

F. vesiculosus.—In Scotland this is sometimes called *Black tang;* sometimes *Kelp ware;* and when the receptacles are large and swollen, *Strawberry-ware.* The Norwegians call it *Kue tang*, because their cows feed on it. It is the *Quercus marina* or *Sea oak* of the older writers. *F. inflatus* of Linnæus and Lightfoot, and *F. spiralis* of English botany, are to be considered as varieties only of this species. The colour is a pale olive green, which becomes dull and almost black as the plant dries. It grows most plentifully on all our rocky shores, often not much below flood-mark. It is readily distinguished from *F. nodosus* by the air-vesicles very generally occurring in parallel pairs, while in *F. nodosus* they are single; and from *F. serratus*, by the edges of the frond being entire, or wanting the serratures which mark that species. It is generally from one to three feet long. It is the species most highly prized for the manufacture of kelp; being rich in alkaline salts. In the north and west of Scotland many hundred tons of this species were yearly cut from the rocks, with old reaping hooks. To the Scottish islanders it is likewise valuable in another way; it constitutes a considerable part of the winter food of their horses, cattle, and sheep, which seem instinctively to migrate from the hills to the sea-shore at the ebbing of the tide. Lightfoot mentions that during severe snow-storms, stags have been known to descend from the Scottish mountains to the shores, and to feed chiefly on this species. Linnæus says, that the people in Gothland often boil the plant, and mixing it with some coarse flour, feed their pigs with it, and that it has hence received the name of *Swine-tang*. In the Channel islands it affords firing. In Jersey, in particular, it is collected and dried in July, and then housed for winter fuel. It is there also employed in smoke-drying pork, beef, and fish.

F. nodosus.—This is very common on the rocky shores of this country, growing about half-way between flood-mark and the ebb; often on the intermediate space between *F. vesiculosus* and *serratus*, though it sometimes grows nearest to high-water mark. The fronds are from two to six feet in length, and at short distances swell into large oblong vesicles or air-bladders; by which, though not mentioned in the specific character, the plant is more familiarly distinguished, and from which it has derived its title *nodosus*. Boys amuse themselves by cutting them transversely near the end, and making whistles of them: hence the name *sea-whistles* sometimes bestowed on the plant. These receptacles acquire a yellow colour, and give occasion to the name of *yellow tang*, by which this species is known in Orkney. Like the last species, it is much used by the kelp-makers, and it often gets the name of *kelp wrack*.

F. serratus.—This is sometimes called *black wrack*, or *prickly tang*, sometimes simply *ware*. It is distinguished at first sight by the edges being serrated, and by the absence of air-vesicles. It is only uncovered at ebb tide, growing, as already remarked, in deeper water than *F. vesiculosus*, or *nodosus*. In its mode of growth, it forms a pulvillum or circular tuft, spreading out on every side from a central point or attachment. When fresh, the frond is of a dark olive green colour; when cast ashore and dried on the beach, it is almost black. It is very frequently overrun by the small coralline called *Sertularia pumila*, or sea-tamarisk. The black wrack is preferred for covering lobsters, or other shell-fish, that are to be kept alive during land-carriage, being less apt to run into fermentation than some others which abound with mucus.

F. loreus.—This species is well known by the name of *sea-thongs*. In Orkney it is called *drew*. It is pretty common in the north of Scotland and its islands, particularly on shelving sandstone rocks. When in a young state, before the *thongs* have grown, it forms a concave disc or cup, and gives to the rocks the appearance of being covered with some sort of mushroom, as mentioned in the specific character. From this circumstance, it is described by some old writers as *Fucus fungis affinis;* and it is perhaps the

Fungus phasganoides of others. The extended strap-shaped fronds, generally two in number, arise from the centre of the cup. They are dichotomous, or divide into two at intervals. They are generally three, often six, or even ten feet in length. Borlase, indeed, in his 'History of Cornwall,' mentions that on that coast, they are sometimes found twenty feet long. The colour is olive green, with a tinge of brown. The plant is pulpy and succulent, and a good deal of excellent kelp is made from it in Orkney. It is a perennial species, or at least the plants require two years to come to perfection.

F. filum or *Scytosiphon filum*.—This species is frequently called *sea-lace*. In Orkney, it gets the name of *cat-gut*, and in Shetland *lucky minny's lines*. The length to which it grows is amazing, not less than from twenty to forty feet. Lightfoot mentions, that the stalks, skinned when half dry and twisted, acquire such strength and toughness, as to be used for fishing-line, like Indian grass,—which, although it has got this vegetable name, is an animal substance, attached to the ovaries of some of the small foreign sharks. The plant consists of a simple frond, without branches. It is of a deep olive colour. It floats about in the manner of *Sparganium natans*, following the course of the waves; but, as remarked by Linnæus, it lies immediately under the surface of the water, not on it. In Scalpa bay, near Kirkwall in Orkney, we have sailed through meadows of it in a pinnace not without some difficulty, where the water was between three and four fathoms deep, and where of course the waving weeds must at least have been from twenty to thirty feet long. This, too, was the growth of one season; for the storms of winter completely sweep it from the bay every season.

F. digitatus or *Laminaria digitata*.—This species has in England received the appellation of *sea-girdles* and *hangers*, and in Scotland it is very generally known by the name of *tangle:* in Orkney it is called *red-ware*. It is the *Skalmetare* of the Norwegians, and the *slatmhara* or sea-wand of the Scots Highlanders. It is one of the largest native species, having a stem often three feet in length, and a large divided frond; and was denominated *phycodendron* or *Fucus arboreus* by some of the older writers. It is very abundant on all our rocky shores, growing chiefly on rocks which are only partially uncovered at the lowest ebbs, so that in neap tides the fronds are scarcely perceptible. The root consists of a congeries of thick horny fibres, often covered with Balanus striatus, and the interstices inhabited by Asterias sphærulata and other vermes. In deep water, exposed to a moderate current, but protected from the heavy action of the waves, it attains a great size, the stalk becoming as thick as one's wrist, from three to four feet long, and the fronds of corresponding length, perhaps from ten to twelve feet. In Scotland the stems are sometimes put to rather an unexpected use,—the making of knife handles. A pretty thick stem is selected, and cut into pieces about four inches long. Into these, while fresh, are stuck blades of knives, such as gardeners use for pruning and grafting. As the stem dries it contracts and hardens, closely and firmly embracing the hilt of the blade. In the course of some months the handles become quite firm, and very hard and shrivelled, so that, when tipt with metal, they are hardly to be distinguished from hartshorn. In the north of Scotland, and especially in the Orkney and Shetland islands, the large stalks are dried and used as fuel. This is likewise done in Norway, and on some of the shores of France, where fuel is nearly equally scarce, but much less needed. The stems are generally invested with many parasitic fuci and confervæ.

F. bulbosus or *Laminaria bulbosa*.—This is the *Fucus polyschides* of the *Flora Scotica*, sometimes called *sea furbelows*. In size it far exceeds any other sea-weed found on our shores, and is certainly not undeserving the titles of *giganteus* and *arboreus*, sometimes bestowed on it by the earlier botanists. It is plentiful in the Pentland frith, and numbers of large specimens are frequently cast ashore in the Bay of Thurso, as well as on the Orkneys. It is likewise pretty common among the Western islands. It is found more sparingly on the east coast of Scotland. On the shores of the south of England, of France, and in the Mediterranean, it is very abundant. It is always found in deep water.

F. saccharinus or *Laminaria saccharina*.—This species is often called *sea-belt*. It is very common, and one of the largest of our fuci. The colour is a deep olive brown, sometimes partly green. Lightfoot mentions, that the common people on the coast of England sometimes boil this species as a pot-herb. The Icelanders, we are told by Anderson, boil it in milk to the consistence of pottage, and eat it with a spoon. They are also said to soak it in fresh water, dry it in the sun, and then lay it up in wooden vessels; it soon becomes covered with a white efflorescence of salt, which has a sweetish taste, and in this state they eat it with butter. Lastly, it is mentioned that they feed their cattle with the plant, both in its recent and dry state. There is, however, every reason to think that all this is more properly applicable to *Halymenia palmata* or dulse, than to the true *F. saccharinus*.

F. esculentus or *Laminaria esculenta*.—This is called *Badderlocks* on the east coast of Scotland; and in the Orkneys, *Honey-ware*. In Norway it is, by way of eminence, styled *tare* or ware. It grows on rocks in pretty deep water, commonly in places where the tips of the fronds can reach the surface at ebb-tide. The stalk is generally from six inches to a foot in length; and near its base occurs a whorl of pinnæ. The frond varies from six to twenty feet in length, with a mid-rib extending the whole way. The mid-rib, stripped of its membrane, is the part chiefly eaten; but in some places, particularly in Orkney, the pinnæ are also eaten, under the name of *mirkles*. Mr. Turner mentions that these are likewise called *keys*, and are only brought to market when thick and fleshy, which is generally in August and September.

F. palmatus or *Halymenia palmata*.—This is the *dulse* of the lowland Scots, and the *duilliosg* of the Highlanders. In Ireland it is called *dillesk;* and it is there first washed in fresh water, and then dried, before being used. In this state it is often made up into rolls, and chewed like tobacco. The Icelanders call it *sol*. The Norwegians name it *sou-soell* or sheep's-weed, and Bishop Gunner has therefore adopted the name *Fucus ovinus*, observing that sheep and goats betake themselves in great numbers eagerly to the shore at ebb-tide to obtain this pleasant food. "Buy dulse and tangle," is one of the Edinburgh cries, *tangle* meaning the tender stalks and very young fronds of *Fucus digitatus*. Both are eaten recent from the sea, commonly without any preparation; they are sometimes considered as forming a salad, but more generally are used as a whet. Dulse is now very seldom fried and brought to table. It is said, that the inhabitants of the Greek islands are fond of this species, adding it to ragouts and olios, to which it communicates a red colour, and at the same time imparts some of its rich and gelatinous qualities. The dried leaves infused in water exhale an odour somewhat resembling that of sweet violets, and they communicate that flavour to vegetables with which they are mixed. *Fucus palmatus* grows not uncommonly on rocks which are barely uncovered at the ebb of the tide; but it is more frequent as a parasite on *Fucus nodosus;* and it occurs also on the stems of *Fucus digitatus*, attaining in this situation a considerable size, perhaps twelve or fifteen inches long, while in general it is only about six or eight inches. It is soft and limber, and does not become rigid by drying, being of a more loose texture than many other seaweeds.

F. edulis or *Halymenia edulis.*—This is not uncommon in Scotland, and being thick and succulent when young, is frequently preferred to *F. palmatus*, especially for roasting in the frying-pan.

F. ciliatus or *Sphærococcus ciliatus.*—This is not very common on our shores: it is sometimes, however, mixed with *F. palmatus*, and sold and eaten as dulse along with that species. It is distinguished not only by its cilia or fringes, but its fine red colour, and almost pellucid substance. It was formerly known by the names of *F. lanceolatus*, and *holosetaceus*.

F. pinnatifidus or *Chondria pinnatifida.*—In Scotland, this is called *Pepper-dulse*, from its hot biting taste. On account of this quality, although its smell is not very prepossessing, it is sometimes eaten along with the common dulse. In Iceland, it is believed, it is still used in place of a spice. It appears to be an annual, and its pungency is considered as greatest in the early part of the summer. It is very common on all our shelving rocky shores, growing along with *F. palmatus* and *crispus*, and *Corallina officinalis*. It is subject to considerable variations, particularly in colour; being frequently olive yellow, but sometimes tinged with red, or dark red approaching to purple.

Many of the fuci, and particularly the Florideæ of Lamouroux, make a beautiful appearance when preserved in a herbarium. All of them require to be soaked for some time in fresh water, and they are the better for being repeatedly rinsed in renewed basins of water, to cleanse away and extract as much as possible the sea-salt which adheres to them, or with which they are impregnated. The larger sort need no other preparation; but are to be dried between folds of blotting paper, and pressed in the manner of herbaceous plants. The finer leaved fuci must be treated in a different way. After being washed, as above directed, in repeated waters, till no impurities of any kind remain, they are to be separately floated out in a large shallow dish containing water, so that their most minute and delicate branches may be fully expanded. For disentangling the nice ramifications, a common pin, or a sharp-pointed pen, may be employed. A piece of stiff, but fine and smooth writing paper, is then to be gently introduced under the specimen, and the minute branchlets being again spread out where they may have been disordered, the paper is to be cautiously and slowly inclined, and at last drawn out, so as to contain on its surface the plant in its fully expanded state. After this, most of the delicate species, if carefully dried and pressed, adhere to the paper by their own gluten, and require no farther care.

FUDDER. A cart load. The name is provincial, and is used principally in reference to lead.

FUEL. Doctor Black divides fuels into five classes. The first comprehends the fluid inflammable bodies; the second, peat or turf; the third, charcoal of wood; the fourth, pit-coal charred; and the fifth, wood, or pit-coal, in a crude state, and capable of yielding a copious and bright flame. The fluid inflammables are considered as distinct from the solid, on this account, that they are capable of burning upon a wick, and become in this way the most manageable sources of heat: though, on account of their price, they are never employed for producing it in great quantities, and are only used when a gentle degree, or a small quantity of heat, is sufficient. The species which belong to this class are alcohol and different oils. The first of these, alcohol, when pure and free of water, is as convenient and manageable a fuel for producing moderate or gentle heats as can be desired. Its flame is perfectly clean, and free from any kind of soot; it can easily be made to burn slower or faster, and to produce less or more heat, by changing the size or number of the wicks upon which it burns; for, as long as these are fed with spirit, in a proper manner, they continue to yield flame of precisely the same strength. The cotton, or other materials, of which the wick is composed, is not scorched or consumed in the least, because the spirit with which it is constantly soaked is incapable of becoming hotter than 174° Fahrenheit, which is considerably below the heat of boiling water. It is only the vapour that arises from it which is hotter, and this, too, only in its outer parts, that are most remote from the wick, and where only the combustion is going on, in consequence of communication and contact with the air. At the same time, as the alcohol is totally volatile, it does not leave any fixed matter, which, by being accumulated on the wick, might render it foul, and fill up its pores. The wick, therefore, continues to imbibe the spirit as freely, after some time, as it did at the first. These are the qualities of alcohol as a fuel. But these qualities belong only to a spirit that is very pure. If it be weak, and contain water, the water does not evaporate so fast from the wick as the more spirituous part; and the wick becomes, after some time, so much soaked with water, that it does not imbibe the spirit properly. The flame becomes much weaker, or is altogether extinguished. When alcohol is used as a fuel, therefore, it ought to be made as strong, or free from water, as possible.—Oil, although fluid like spirit of wine, and capable of burning in a similar manner, is not so convenient in many respects. It is disposed to emit soot; and this, applying itself to the bottom of the vessel exposed to it, and increasing in thickness, forms, by degrees, a soft and spongy medium, through which heat is not so freely and quickly transmitted. It is true we can prevent this entirely by using very small wicks, and increasing the number, if necessary, to produce the heat required. Or we may employ one of those lamps, in which a stream of air is allowed to rise through the middle of the flame, or to pass over its surface with such velocity as to produce a more complete inflammation than ordinary. But we shall be as much embarrassed in another way; for the oils commonly used, being capable of assuming a heat greatly above that of boiling water, scorch and burn the wick, and change its texture, so that it does not imbibe the oil so fast as before. Some have attempted a remedy, by making the wick of incombustible materials, as asbestos or wire; but still, as the oil does not totally evaporate, but leaves a small quantity of gross, fixed, carbonaceous matter, this, constantly accumulating, clogs the wick to such a degree, that the oil cannot ascend, the flames become weaker, and, in some cases, are entirely extinguished. There is, however, a difference among the different oils in this respect, some being more totally volatile than others. But the best are troublesome in this way, and the only remedy is, to change the wicks often, though we can hardly do this and be sure of keeping always an equal flame.

The second kind of fuel mentioned, peat, is so spongy, that, compared with the more solid fuels, it is unfit to be employed for producing very strong heats. It is too bulky for this; we cannot put into a furnace, at a time, a quantity that corresponds with the quick consumption that must necessarily go on when the heat is violent. There is, no doubt, a great difference in this respect among different kinds of this fuel; but this is the general character of it. However, when we desire to produce and keep up, by means of cheap fuel, an extremely mild, gentle heat, we can hardly use any thing better than peat. But it is best to have it previously charred, that is, scorched, or burnt to black coal. The advantages gained by charring are considerable. When it is prepared for use in that manner, it is capable of being made to burn more slowly and gently, or will bear, without being extinguished altogether, a greater diminution of the quantity of air with which it is supplied, than any other of the solid fuels.

The next fuel in order is the charcoal of wood. This is prepared by piling up billets of wood into a pyramidal heap, with several spiracles, or flues, formed through the pile. Chips and brushwood are put into those below, and the whole is so constructed as to kindle throughout in a very short time. It would burst out into a blaze, and be quickly consumed to ashes, were it not covered all over with earth or clay, beaten close, leaving openings at all the spiracles. These are carefully watched; and whenever the white, watery smoke is observed to be succeeded by thin, blue and transparent smoke, the hole is immediately stopped; this being the indication of all the watery vapour being gone, and the burning of the true coaly matter commencing. Thus is a pretty strong red heat raised through the whole mass, and all the volatile matters are dissipated by it, and nothing now remains but the charcoal. The holes being all stopped in succession, as this change of the smoke is observed, the fire goes out for want of air. The pile is now allowed to cool. This requires many days; for, charcoal being a very bad conductor of heat, the pile long remains red hot in the centre, and, if opened in this state, would instantly burn with fury. Small quantities may be procured at any time, by burning wood in close vessels. Little pieces may be very finely prepared, at any time, by plunging the wood into lead melted and red hot. This kind of fuel is very much used by chemists, and has many good properties. It kindles quickly, emits few watery or other vapours while burning, and, when consumed, leaves few ashes, and those very light. They are, therefore, easily blown away, so that the fire continues open, or pervious to the current of air which must pass through it to keep it burning. This sort of fuel, too, is capable of producing as intense a heat as can be obtained by any; but in violent heats it is quickly consumed, and needs to be frequently supplied.

Fossil coals charred, called *cinders*, or *coke*, have, in many respects, the same properties as charcoal of wood; as kindling more readily in furnaces than when they are not charred, and not emitting watery, or other gross smoke, while they burn. This sort of charcoal is even greatly superior to the other in some properties. It is a much stronger fuel, or contains the combustible matter in greater quantity, or in a more condensed state. It is, therefore, consumed much more slowly on all occasions, and particularly when employed for producing intense melting heats. The only inconveniences that attend it are, that, as it consumes, it leaves much more ashes than the other, and these much heavier too, which are, therefore, liable to collect in such quantity as to obstruct the free passage of air through the fire; and further, that when the heat is very intense, these ashes are disposed to melt or vitrify into a tenacious, drossy substance, which clogs the grate, the sides of the furnace, and the vessels. This last inconvenience is only troublesome, however, when the heat required is very intense. In ordinary heat, the ashes do not melt, and though they are more copious and heavy than those of charcoal of wood, they seldom choke up the fire considerably, unless the bars of the grate be too close together. This fuel, therefore, is preferable, in most cases, to the charcoal of wood, on account of its burning much longer, or giving much more heat before it is consumed. The heat produced by equal quantities, by weight, of pit-coal, wood-charcoal, and wood itself, is nearly in the proportion of 5, 4, and 3. The reason why both these kinds of charcoal are preferred, on most occasions, in experimental chemistry, to the crude wood, or fossil coal, from which they are produced, is, that the crude fuels are deprived, by charring, of a considerable quantity of water, and some other volatile principles, which are evaporated during the process of charring, in the form of sooty smoke or flame. These volatile parts, while they remain in the fuel, make it unfit (or less fit) for many purposes in chemistry. For, besides obstructing the vents with sooty matter, they require much heat to evaporate them; and therefore the heat of the furnace, in which they are burnt, is much diminished and wasted by every addition of fresh fuel, until the fresh fuel is completely inflamed, and restores the heat to its former strength. But these great and sudden variations of the heat of a furnace are quite inconvenient in most chemical processes. In the greater number of chemical operations, therefore, it is much more convenient to use charred fuel, than the same fuel in its natural state.—It is proper to be on our guard against the dangerous nature of the burnt air which arises from charcoal of all kinds. Charcoal burns without visible smoke. The air arising from it appears to the eye as pure and as clear as common air. Hence it is much used by those persons who are studious of neatness and cleanliness in their apartments. But this very circumstance should make us more watchful against its effects, which may prove dangerous, in the highest degree, before we are aware of it. The air arising from common crude fuel is, no doubt, as bad, but the smoke renders it disagreeable before it becomes dangerous. The first sensation is a slight sense of weakness: the limbs seem to require a little attention, to prevent falling. A slight giddiness succeeds, accompanied by a feeling of a flush or glow in the face and neck. Soon after, the person becomes drowsy, would sit down, but commonly falls on the floor, insensible of all about him, and breathes strong, snoring as in an apoplexy. If the person is alarmed in time, and escapes into the open air, he is commonly seized with a violent headache, which gradually abates. But when the effect is completed, as above described, death very soon ensues, unless relief be obtained. There is usually a foaming at the mouth, a great flush or suffusion over the face and neck, and every indication of an oppression of the brain, by this accumulation of blood. The most successful treatment is, to take off a quantity of blood immediately, and throw cold water on the head repeatedly. A strong stimulus, such as hartshorn, applied to the soles of the feet, has also a very good effect.

The fifth and last kind of fuel is wood, or fossil coals, in their crude state, which it is proper to distinguish from the charcoals of the same substances. The difference consists in their giving a copious and bright flame, when plenty of air is admitted to them, in consequence of which they must be considered as fuels very different from charcoal, and adapted to different purposes. Flaming fuel cannot be managed like the charcoals. If little air be admitted, it gives no flame, but sooty vapour, and a diminution of heat. And if much air be admitted, to make those vapours break out into flame, the heat is too violent. These flaming fuels, however, have their particular uses, for which the others are far less proper. For flame, when produced in great quantity, and made to burn violently, by mixing it with a proper quantity of fresh air, by driving it on the subject, and throwing it into whirls and eddies, which mix the air with every part of the hot vapour, gives a most intense heat. This proceeds from the vaporous nature of flame, and the perfect miscibility of it with the air. As the immediate contact and action of the air are necessary to the burning of every combustible body, so the air, when properly applied, acts with far greater advantage on flame than on the solid and fixed inflammable bodies; for when air is applied to these last, it can only act on their surface, or the particles of them that are outermost; whereas, flame being a vapour or elastic fluid, the air, by proper contrivances, can be intimately mixed with it, and made to act on every part of it, external and internal, at the same time. The great power of flame, which is the consequence of this, does not appear when we try small quantities of it, and allow it to burn quietly, because the air is not intimately mixed with it, but acts only on the outside, and the quantity of burning matter in the surface of a small flame is too small to produce much effect. But when flame is produced in large quantity, and is properly mixed and agitated with air, its power to heat bodies is immensely increased. It is therefore peculiarly proper for heating large quantities of matter to a violent degree, especially if the contact of solid fuel with such matter is inconvenient. Flaming fuel is used, for this reason, in many operations performed on large quantities of metal, or metallic minerals, in the making of glass, and in the baking or burning of all kinds of earthen ware. The potter's kiln is a cylindrical cavity, filled from the bottom to the top with columns of wares: the only interstices are those that are left between the columns; and the flame, when produced in sufficient quantity, is a torrent of liquid fire, constantly flowing up through the whole of the interstices, which heats the whole pile in an equal manner. Flaming fuel is also proper in many works or manufactories, in which much fuel is consumed, as in breweries, distilleries, and the like. In such works, it is evidently worth while to contrive the furnaces so, that heat may be obtained from the volatile parts of the fuel, as well as from the fixed; for when this is done, less fuel serves the purpose than would otherwise be necessary. But this is little attended to, or ill understood, in many of those manufactories. It is not uncommon to see vast clouds of black smoke and vapour coming out of their vents.—This happens in consequence of their throwing too large a quantity of crude fuel into the furnace at once. The heat is not sufficient to inflame it quickly, and the consequence is a great loss of heat.

The quantity of watery fluid contained in fuel greatly affects the amount of heat it produces; much more, indeed, than is commonly admitted in practice. It is a well known law of chemistry, that the evaporation of liquids, or their conversion into steam, consumes, and renders latent, a great amount of caloric. When green wood, or wet coals, are added to the fire, they abstract from it, by degrees, a sufficient part of its heat, to convert their own sap or moisture into steam, before they are capable of being burnt. And as long as any considerable part of this fluid remains unevaporated, the combustion goes on slowly, the fire is dull, and the heat feeble. Green wood commonly contains a third, or more, of its weight of watery fluid, the quantity varying according to the greater or less porosity of different trees. Nothing is further from true economy than to burn green wood, or wet coal, on the supposition that, because they are more durable, they will in the end prove more cheap. It is true, their consumption is less rapid; but to produce a given amount of heat, a far greater amount of fuel must be consumed. Wood that is dried under cover is better than wood dried in the open air, being more free from decomposition.

FULLER'S EARTH. An aluminous mineral, used for scouring cloth in the ulterior processes of its manufacture, and especially for clearing it from grease. It is so aluminous as to be strictly a species of clay; and it owes the whole of its cleansing power to the affinity of its alumina for oily and fatty substances. It has generally a greyish, ashy, brown colour, but is sometimes greenish, and may be found of all varieties of tint from very pale to almost black. It is hard, firm, and compact, has a rough and somewhat dusty surface, and adheres slightly to the tongue; yet it feels soft to the touch, does not stain the hands, and has a little harshness between the teeth, and melts freely in the mouth. When immersed in water, it silently and gradually swells in bulk, and eventually falls into a fine soft pulp. A specimen of it from Reigate in Surrey was found by Klaproth to consist of 53 per cent. of silica. 10 of alumina, ½ of lime, 1¼ of magnesia, 9¾ of oxide of iron, ⅒ of common salt, and 24 of water, besides 1·4 of matters lost in the analysis; and a specimen from Nimptch in Silesia was found to consist of 48½ per cent. of silica, 15½ of alumina, 1½ of magnesia, 7 of oxide of iron, 25½ of water, and 2 of loss. Large quantities of it occur in Hampshire and Bedfordshire; and considerable quantities exist in other parts of England, and in various parts of Scotland and Ireland. The silica of all fuller's earth must exist in a finely comminuted state, else it would abrade and cut the cloth. Whenever fuller's earth occurs in considerable plenty, it may be applied as a very enriching manure to arenaceous lands.

FULLER'S THISTLE. See Teazel.

FUMARIA. See Fumitory.

FUMIGATION. The artificial diffusion of medicated smoke or pungent gas through a house or an apartment, for the neutralizing of infection or the destruction of insects. Chloride of lime is very commonly used for destroying infection, and tobacco smoke for destroying aphides. See the articles Chlorine and Tobacco. A cheap and facile fumigator, is a peculiarly formed pipe, made to fit any pair of common bellows.

FUMITORY,—botanically *Fumaria*. A genus of hardy annual plants, constituting the type of the natural order Fumariaceæ. This order is nearly allied to the poppy family, and was formerly regarded as a part of it. The species belonging to it in Britain, including both the indigenous and the exotic, amount to about 50, and are comprised in six genera. All are hardy and herbaceous, and have finely cut leaves and a delicate appearance; most inhabit thickets and hedge-banks in the most temperate countries of the northern hemisphere; nearly all have a large proportion of watery juice, and possess slightly aperient and diaphoretic properties; and many are very pleasing ornaments of the flower-border.

Seven perennial and two annual species formerly included in the genus fumaria, are now distributed among the other five genera of the order; and only four indigenous species, four introduced exotic species, and two or three unintroduced exotic species, all annuals, are now considered as true fumitories.—The common or officinal species, *Fumaria officinalis*, is a somewhat common weed of hedge banks and arable lands in many parts of Britain. Its root is tapering; its stem is much branched and about two feet high; its leaves are principally alternate, smooth, and twice or thrice pinnate; and its flowers have a pink or rose colour, and grow in clusters, and bloom from May till August. Horses entirely refuse this plant, and goats dislike it when it is full grown; but cows and sheep readily enough eat it. Its leaves have a saline and bitter taste; and its juice was formerly held in great popular esteem for bilious colics.—The intermediate fumitory, *Fumaria media*, resembles the common species, but is much larger and more showy, has flesh-coloured flowers, and climbs round other plants, by the aid of its tendrils, to the height of 3 or 4 feet. It occurs in the corn fields of various parts of Britain, but is much more rare than the common species; and it is worthy of a place in the flower garden, and makes a beautiful appearance when so sown as to climb up a hedge.—The small-flowered fumitory, *Fumaria parviflora*, frequents the corn fields of some parts of England, attains a height of about two feet, carries pink or pale red flowers, and blooms in August and September.—All the introduced exotic species are ornamental, and have either pink or flesh-coloured flowers. Both the popular and the botanical names of the genus are formed from a word signifying smoke, and allude to a disagreeable smoky smell of the plants.

FUNGI. An extensive family of plants, belonging to the Linnæan class *Cryptogamia*. Many of the species are commonly called *mushrooms*. These plants vary greatly in size, form, colour and consistence. They frequently have the form of a parasol, or are filamentous, membranaceous, tuberous, frothlike, &c. They are found of all colours, except green, but their prevailing hue is greyish-white, or yellowish. Their consistence is coriaceous, fleshy, spongy, gelatinous, corky or ligneous, but never herbaceous. They are destitute of leaves or flowers, and differ much in their appearance from other plants. Their anatomical structure, when examined with the microscope, is found to consist entirely of cells, some rounded, and others more or less elongated. When arrived at maturity, they all present certain minute coloured globules, which are considered reproductive, and analogous to the seeds of other vegetables. The situation of these globules is different in the different genera; sometimes internal, as in the truffle and puff-ball, or covering the entire surface, in laminæ on the inferior surface, at the opening of tubes, in furrows, capsules, or upon particular appendages, either attached on one side, or floating in mucilaginous matter. The abundance of these globules in some fungi is incalculable. 2,400 species of fungi are now known, which are distributed in about 160 genera. No other vegetables grow and develop themselves so quickly as fungi. It is not unusual to see hundreds of them, which have sprung up in the course of a single night. It is well known how rapidly mould, which is a fungus, covers certain substances; some species in a few minutes pass through the whole course of their existence; others live only a few hours; but their duration is generally several days, and even a season, and some continue for many years, but these are composed of several successive generations. They delight in moist, shady places, and grow on all animal and vegetable substances in the state of decomposition, on dead and living trees, on the leaves of all plants; and some species are confined to particular plants, under the surface of the earth; but none are truly aquatic, though some float on the surface of fermented liquors. Some fungi grow even in the interior of vegetables, and in this respect are analogous to intestinal worms. All possess a peculiar odour, by which their presence may be recognised. Their taste is insipid, or sometimes nauseous, acrid, styptic, or caustic, and in some of the edible species very agreeable. Many species of mushrooms have been used for food from time immemorial in China, India and Africa, and more recently in Europe, where they are now consumed in vast quantities. In some parts of Italy, the inhabitants have been at times reduced entirely to this aliment. They are cultivated in layers throughout all Europe, by which means a continual supply is furnished during the season; and various methods have been devised for preserving them through the remainder of the year. Many species are exceedingly poisonous, producing nausea, vomiting, convulsions, and speedy death. It has been observed, that acids diminish considerably the deleterious effects of mushrooms, as also sometimes boiling. In cases of poisoning, an emetic should be immediately administered. In gathering mushrooms for the table, great care should be taken to exclude all poisonous species; those that possess a milky juice are generally acrid, and should be rejected, as also those which have a sombre hue, and whose substance is heavy, tough or fibrous, and those which grow in dark places, or upon old trunks of trees. Some species require the parts of fructification only to be removed; but besides the poisonous species, all are liable to become pernicious, unless certain precautions are taken. If, for instance, they have lost their freshness, or are in a state of decomposition, and even at the best of times, they should be eaten with moderation. As the poisonous species can be distinguished by no common character, it is better to use those only whose innocence is well established. Some species are employed in dyeing yellow. Other fungi are the bane of the husbandman, destroying in a short time the fruits of his labour; as blight, mildew, &c. See articles Æcidium, Agaricus, Boletus, Botrytis, Mushroom, Puccinia,Uredo, and Truffle.

"Lindley and other eminent botanists," remarks the author of Blights of the Wheat, "are of opinion that fungi might be broken up regularly into orders, founded on a knowledge of their peculiarities of structure. 1. When the *hymenium* (which is a diminutive of ὑμὴν, *humen*, skin or membrane,) is naked, they might be called *hymeno-mycetes;* the term *mycetes* being derived from the Greek word μύκης, (*mukes*,) a fungus. Such are all the agarics, or mushroom-tribes. Their spores are set in fours, on little processes called *sporophores*, or spore-bearers. 2. When the *hymenium* is enclosed in a case, or *peridium*, the appropriate name is *gastero-mycetes*, from γαστὴρ, (*gaster*,) a stomach. The spores of these are generally also in fours. This order would include puff-balls, and sphœrias. 3. The next order is proposed to be named *coniomycetes*, from κόνις, (*conis*,) dust. They have a dust-like appearance, as every one knows who has noticed the *uredines* of the corn-plants. These have their spores single, or occasionally in sevens. 4. The fourth order would be designated *hymphoycetes*, from ὕφος, (*huphos*,) a web. Such are the fungi attacking vetches, potatoes, etc., called *botrytides*, from βότρυς. (*botrus*,) a bunch of grapes, the spores hanging naked like berries on the threads. They are also often in sevens in this order. 5. The fifth would be termed *ascomycetes*, from ἀσκὸς, (*askos*,) a bag, the sporidia, or spore-cases, generally being contained in eights, in vesicles. Of this kind is the *erysiphe*, attacking peach-trees, hops, pease, and beans. 6. The sixth and last should be called *physo-mycetes*, from φύσα, (*phusa*,) a blown bladder, because the spores are surmounted by a sort of vesicular veil, called by botanists a *sporangium*. The thallus of these fungi is floccose. Some fungi are beautifully phosphorescent in the dark, and give the natural arches of certain mines the appearance of enchanted vaults teeming with indescribable splendour. These luminous fungi chiefly belong to the kind called *rhizo-morpha*, so named because they assume the appearance of masses of roots. They abound in cellars and other places under-ground. Rhizo-morpha is the matter of fungi developed in an anomalous condition. A curious example was lately placed in the author's hands by Professor Henslow. It had grown on the woollen garments of a body, found in a coffin hermetically sealed in a deep vault of Roman construction. Sometimes it has been said that the hair has grown under such circumstances, but in all probability this appearance was merely the similar development of a species of rhizomorpha; and, in fact, the one alluded to might have easily been so mistaken. The parts of the globe in which fungi grow ought not to pass unnoticed; for where the range of the thermometer is about the same, and climates are analogous, there is such an identity between the fungi, that it would be almost possible to draw *iso-fungal* lines on a map of the earth. Many more observations are yet required on all the natural productions called by the common name of fungi. Some which have been long regarded as fungi are merely blisters of *acari*, or plant-lice; they are found on leaves of pear-trees, and, till examined carefully, would easily mislead the observer. Others, as for instance those bearing the name of *erineum*, are only diseases of the superficial tissue of the leaves where they make their appearance. It is very essential, therefore, that we would show that diseases of plants attributed to fungi do actually proceed from them. As may be conceived, speculations upon the fungi have been not a few. They have arisen out of their rapid growth, meteoric character, the increase of species under certain circumstances, the development of parasitic fungi only on particular parts of plants and nowhere else, and many other ascertained facts. But it is best at once to state, that the only *truth-like* solution of their source is the almost universal diffusion of their inconceivably small sporules, which are so numerous and minute, that it is not easy to conceive any place where they may not abound. They are ever at hand, only awaiting suitable conditions for springing up into existence. It may be said of the great majority of the fungals, that one of such conditions is that they should find a *matrix*, or suitable place for their growth, of some organic matter in a state of decomposition. Herein again such fungi differ from lichens, which are often found attached to living parts of vegetables. Hence fungi have not unappropriately been designated 'the scavengers of nature,' as consuming those decomposing substances which would, if left to decay, prove injurious to the health of animals. This is one of those beautiful provisions of a merciful Providence, whereby a natural antidote is called into existence out of the very dangers themselves which arise from natural laws, and tends to beget in the Christian mind that veneration with which the gospel instructs us to regard such evident manifestations of wisdom and goodness."

FUNGIN. The fleshy matter of the mushroom, purified by digestion in slightly alkaline hot water. It has a similar chemical constitution to animal substances, is highly nutritious, and, when digested in a mixture of nitric acid and water, gives out nitrogen.

FUNGUS. A spongy morbid excrescence in bad wounds and ulcers of animals. It is popularly called proud flesh. It requires to be removed before the place of its growth will heal; and it may generally be destroyed by the application of caustic substances, such as sulphate of copper, red precipitate, and the nitrate of silver.

FUNKIA. A genus of hardy, ornamental, herbaceous plants, of the day-lily family. It comprises several Japanese species which were formerly included in the day-lily genus; and several additional Japanese species of recent introduction. The flowers of its several species differ widely from one another in colour, and comprise brown, white, lilac, and pale purple; and the plants of most have a height of about 15 inches. See the article DAY-LILY.

FUR. The hairy skin of a quadruped, dressed with alum, and esteemed on account of its hair. The obtaining of furs is an extensive and perilous occupation throughout some of the coldest regions of North America; and the dressing and vending of them are distinct and important departments of home occupation. The species chiefly used are those of the sable, the ermine, the beaver, the bear, the hare, and similarly clothed animals; and the varieties most prized are the finest, thickest, glossiest, and freest from grease. The refuse from the dressings of the skins is popularly known as furrier's refuse, and is used in some districts as an excellent manure for light chalky and gravelly soils. It is sold at about 15s. per quarter,—a quantity which, when firmly pressed down, will fill any ordinary cube of 10 bushels; and it is applied to the land at the rate of from 24 to 30 bushels per acre.

FUR. A Furrow. The word, in this sense, is a Scotticism.

FURCRŒA. A genus of tender, ornamental, evergreen, herbaceous plants, of the bromelia family. Eight species are known, and have been introduced to British collections. They are closely akin to the American aloe; and the longest known species, *F. gigantea*, was at one time actually regarded as an agave. This species attains about the same height as the common and most celebrated American aloe; and a species introduced about a dozen years ago, *F. longæva*, attains the enormous height of 50 or 60 feet; but the other species have heights of only from 6 to 12 feet.

FURLONG. The eighth part of a mile.

FUR-MOTH,—scientifically *Tinea Pellionella*. A common and mischievous insect, of the lepidopterous order. It is a congener of the clothes-moth; and strictly resembles that little destroyer in habits. Its breadth, from tip to tip of the expanded wings, is about half an inch; its upper wings are silvery grey, sparcely spotted with black; and its lower wings are light silvery grey, and have long fringes. Its caterpillar closely resembles that of the clothes-moth, and works the same kind of havoc upon furs which the latter does upon woven fabrics,—forming a kind of felted case partly within the substance of the skin, and gnawing off the hairs near the roots.

FURRIERS' REFUSE. See Fur.

FURROW. The long narrow trench made by the plough in tilling land. It means sometimes the temporary trench made by each line or bout of ploughing, more generally the permanent trench which divides two ridges, and occasionally the narrow surface drain which is formed across the ends of these, and which receives and carries off their discharges of water; and in the first of these senses, it may be called the plough-furrow, in the second the ridge-furrow, and in the third the cross-furrow. The operation of furrow-draining is designed to draw off surface water by means of the ridge-furrows and the cross-furrows; and a somewhat analogous operation draws off surface water from tilled clay lands by means of small and narrow spade-cuts called water-furrows. See the article Draining. A furrow-slice is the strip of soil cut out and turned over by the plough in each bout of ploughing. See the article Ploughing. A furrow-roller is specially constructed for rolling the furrows of steep declivities and other difficult situations which do not, without great difficulty, admit the use of the common-roller.

FURROW-SLICE. See Furrow.

FURZE, Gorse, or Whin,—botanically *Ulex*. A genus of evergreen shrubs, of the broom division of the leguminous order. Its plants have spiny, sharp-pointed leaves; two-sepaled calyxes, with small scale-like lateral appendages at their base; yellow papilionaceous flowers; ten monadelphous stamens; and turgid pods, little longer than the calyx. A species which was fomerly ranked as a furze, under the name of *Ulex mitis* or *Ulex genistoides*, and was introduced to Britain about 24 years ago from Spain, and usually attains a height of about 3 feet, was constituted by Link into a separate genus, under the significant name of the leafless cross-spined plant, *Staurocanthus aphyllus*. The Provence furze, *Ulex provincialis*, was introduced to Britain about 24 years ago from the South of Europe, and usually attains a height of about 4 feet, and blooms in July and August. The only other species are three indigenous ones, the Irish, the European, and the dwarf; and these concentrate in themselves the main value of the genus, and possess much interest both as shrubby weeds and as forage plants to the farmer.

The Irish or upright furze, *Ulex Hibernica* or *Ulex stricta*, is a native of light soils in some parts of Ireland. Its habit of growth is much more compact and erect than that of the European or British furze; its height is usually about 6 or 7 feet; its shoots from one stem are comparatively numerous and luxuriant; all its shoots are soft and succulent; its thorns, prickles, or spinous leaves are so tender and soft as not to require any thrashing or bruising in order to be eatable by horses or cattle; and its flowers are few in number, and bloom from August till December. It produces so few seeds as to be but sparcely propagable by sowing, else it might prove a very valuable agricultural plant; yet it roots freely from the cuttings of young shoots, planted in clean arenaceous soil, in a shady situation, about the end of August,—it produces such plantlets from these cuttings in the following spring or summer, as can be readily transplanted in autumn or in the succeeding spring,—and it may, on not a small proportion of farms with light soils and hilly grounds, abundantly repay in forage all the trouble and expense of even this operose process of cultivation.

The European or common furze, *Ulex Europæa*, is everywhere so well known as not to require any description. It abounds on heaths and waste sandy soils, at lower elevations than 900 feet above sea-level, in most parts of Britain; it is abundant also in Portugal and the western parts of France; and it likewise occurs, with more or less frequency, in Belgium, Germany, Denmark, and some other of the mediumly temperate countries of Europe. It prefers thoroughly light, dry, moorish, gravelly, and even rocky situations; and will not grow upon either soft moss or strong wet clays. It covers tracts of land on the borders of moors, variegates the dreary and monotonous landscape of heaths, spreads out in masses upon thin and rock-incumbent carpetings of diluvium or debris, crowns heaps and mounds of gravelly matter excavated from pits and quarries, and appears with fine effect on rocky cliffs and upon the sandy banks and gravelly screens of brooks and rivers. It resembles the common heath in its usurping and gregarious habits, and often extends in great groups and over considerable tracts, to the exclusion of feebler plants. It is injured in any situation by very severe frosts; and may be killed to the ground, on high or exposed spots, in a keen winter; and it makes the best resistance to excessive cold, when it has either been cropped all over by the brousing of sheep, or trained into a compactly bushy form by the use of the pruning-knife. It usually attains a height of from 4 to 7 feet; but it rises, in some situations, to the height of 8 or 9 feet; and a specimen of it, in the most favourable circumstances, may occasionally be found to measure very nearly two feet in the circumference of its stem.

A double-flowered variety of the common furze, *U. E. flore pleno*, is held in estimation as an ornamental shrub, and allowed a place in even small collections and border-groups of hardy ligneous evergreens; and, in consequence of its being propagable only by cuttings, or otherwise from its wood, it is peculiarly suitable for furze-hedges in situations where the adjacent ground requires to be protected from the scattering and growth of furze-seeds. Some other varieties of it, also, are suitable either for ornament or for economy,—particularly the white-flowered furze, the long narrow-spined furze, the short-spined furze, the large French furze, the round-podded furze, and the dwarf furze. But the last of these, *Ulex nana*, is rather a species than a variety; and, in some degree, divides attention with the common furze as an indigenous shrub. The dwarf furze inhabits elevated heaths and dry pastures, while the common furze is fondest of low, waste, shallow grounds; the former has reclining branches, and an ordinary height of only two feet, while the latter has upright branches, and an ordinary height of six feet; and that flowers only in autumn and early winter, while this flowers generally in spring or the beginning of summer, and occasionally at all seasons.

Both the common furze and the dwarf furze, frequently accelerate the formation and increase of soil upon surfaces of very thinly covered rock. The scanty, rudimental soil formed by the decay of lichens and musci, supports a growth of dwarf heaths; the soil formed by the decay of the heaths, supports a growth of furze; and a deep and pasturable or even arable soil is superimposed partly by the decay of the branches of the furze, and still more by the intercepting of the falling debris among the compact and bushy masses of the furze's shoots and groups. The soil of some parts of the mountains of North Wales presents distinct evidence of having been formed by the accumulation of debris and humus from the progressive growth and decay of furze.

Furze is one of those leguminous plants which have elastic pods, and disperse their seeds with a sudden jerk; and it, in consequence, readily extends its dominion on any moor or dry common on which it has obtained a footing. It grows so densely, and spreads itself so closely upon the ground, and carries its flowers at so small an elevation, that if it dropped its seeds direct upon its own site, it would suffocate them, and eventually die out; but it steadily dries its pods to ripeness, holds them tight till they become mature, and then, in warm sunny weather, opens them with an explosion, and jerks their contents to a considerable distance. Any person who has never observed this phenomenon, may break off a twig of whin carrying some apparently ripe pods, and hold it for a few minutes near a fire; and he will find, after taking it away, that the pods will burst open, and disperse their contents with considerable force. A propagation of furze over a moorish waste, therefore, will be rapidly effected by a few furze-plants themselves, if simply stationed at some distance from one another, and allowed to mature their seeds.

Furze may be artificially propagated for any spots or purposes requiring its transplantation, by sowing the seeds very thickly in beds in the same manner as the seeds of cabbage, and planting out the seedlings in the succeeding year in any places where they are wanted; and it may be cultivated as a regular field crop for the feeding of horses and cattle in the following manner, practised by Dr. Anderson:—"After the land is properly prepared for a crop of barley, or such similar crop, the seed of the whin should be sown down with grass seeds. The quantity of seed used may be from 15 lb. to 20 lb. per acre. The young plants of the whin will spring up amongst the crop, and keep alive during the winter. And if the young plants are not choked up by grass or weeds during the early part of the next summer, the whins will grow rapidly after midsummer, and produce a pretty full crop in autumn, which may be cut and used as required, so soon as the green summer food fails."

The use of furze as fuel is confined either to paupers or to the general population of districts where better fuel is scarce and dear. Yet some gravelly and sandy tracts which otherwise would not be worth one shilling per acre, yield every third year a quantity of furze for fuel of the value of from 30s. to 45s. per acre; and many small tracts on moors or rocky hills, which would otherwise be wholly useless, yield enough to comfort the poor, or aid the middle classes, or even assist manufactures. Furze burns rapidly, and generates great heat; and is employed, not only for ordinary purposes by cottiers and farmers, but by bakers for heating ovens, and by maltsters, brick-makers, lime-burners, and others in their respective avocations. A thicket or mass of growing furze intended for fuel is, in many instances, set on fire and partially burned during the winter, so as to have its spines and spinous twigs consumed and its stems and main shoots exsiccated and somewhat charred; and, in spring, its parts are hoed up and carried home by women or children.

Furze, along the summit of an earthen mound or slanting-sided earthen wall, makes a prime fence, and yet has so often been grossly mismanaged in this capacity as to be esteemed by multitudes of persons an utterly worthless fence plant. Furze fences may, in many districts, be seen around plantations, athwart poor pasture-lands, and occasionally in better situations, in the most miserable condition, surmounting ill-made and worse-preserved mounds, shattered by a long contest with neglect and maltreatment, rugged in outline, gawky by overgrowth, gapped by depredation, partially overwhelmed by winter-lodgments of snow, pervious in many places to cattle, everywhere valueless as fences, and nowhere fit for anything but to harbour weeds and vermin. But all such fences owe their evils to abuses, and would have been as bad or worse if, with the same course of miserable treatment, they had consisted of privets or hawthorns. Furze recommends itself for fences by flourishing in many soils and situations where more popular fence-plants could not grow, by maintaining the same breadth and mass of substance and foliage in winter as in summer, by being rapid in growth, and so saving expenses of paling, by forming a dense, compact, spinous mass which no domestic animal can penetrate, by offering great facility of culture in all dry, light, and shallow soils, by living and maintaining all its defensive powers to an unknown longevity, by never requiring to be cut down, by affording an eminently good shelter to stock, by producing food to sheep and cattle and receiving benefit rather than injury from browsing, by prospering under the knife, and by constituting a pleasing object to the eye, and agreeably featuring otherwise cold and bald stretches of landscape. A chief objection to fencing with furze is that the plants scatter their seed and propagate themselves over the adjacent land; but this may be obviated wholly by using the double-flowered variety, and in a main degree by regularly pruning the sown and normal plant; for the furze does not bear seed on shoots of the first year, and though a regularly pruned hedge produces some seeds in its interior it drops almost all of them so completely within its own limits as to suffocate them, and prevent their germination. Another objection is, that the mound for a furze-hedge is so broad as to make a wasteful occupancy of land; but this may, in a considerable degree be obviated by so contracting the mound as to combine perfect stability with a minimum of base.

The earthen wall of a good furze fence may be made six feet wide at bottom, 20 inches wide at top, and about six feet high; its sides should be built firmly with sward-turf, its centre filled with earth, and its top rounded over with soil; the turf and the earth for it should be taken from the spot where they are used; and a shallow ditch should be left along each side of the base, with an interval of 4 inches between the ditch and the wall. The seed, .if the single-flowered plant be used, must be sown in a row along the top of the wall, at the rate of about one pound of seed to 40 roods of the wall. The proper time for constructing the wall is March or April; and the seed, in order to insure its germination, ought to be sown immediately after the wall is completed, or before the fresh soil on the top has had time to dry. A fence of this kind will be complete in the second year after it is made, so that it does not require paling; and if regularly pruned and trimmed once a-year, it will continue for many years to be in prime condition, and altogether impervious; or if it do not undergo a proper annual pruning, it may be kept in good order simply by being generally cut over every third year about the month of April.

Furze may be very profitably cultivated on poor, shallow, dry lands, of hill farms, or on the waste or half-sterile grounds of the most fertile districts, as green food for live stock. It is suitable for use during precisely that part of the year when other green food is most scarce, and when farm-labourers have the greatest amount of available time for gathering and preparing it, or from October till March or the beginning of April. Its old stems, indeed, are too hard and ligneous to be eaten; but all its young shoots are tender and juicy; and a whole crop of it of three years' growth may be annually cut down in daily portions for forage. Even bushes of it in a wild state, whenever sheep, cattle, or deer have access to them, are regularly browsed into a beautifully conical outline, and always present a fresh and vigorous appearance; and clumps and thickets of it within the limits of a mountain sheep-walk are commonly of great value in the maintaining of the flock, and sometimes form their chief sustenance throughout the severe and snowy periods of winter. "Sheep," says Mr. Lawson, "are found to fatten and thrive much better on whins than on grass; yet they seldom touch them until forced to do so from not getting at the grass for snow; but when once accustomed to the whins, they continue to eat them in greater or less quantities according to the state of the pasture, until the young grass comes in in the beginning of summer; hence, when whins are plentiful in the winter pasture, shepherds always look with anxiety for a snow-storm in the early part of that season." Cattle are very fond of furze, and fatten on it as rapidly as on turnips; and cows, when fed on it, produce as much milk as when fed on grass, and the milk is free from bad flavour, and yields very excellent butter. Goats and deer, as well as sheep, either browse upon it as it grows wild, or feed heartily upon it when it is cut and bruised. Horses prefer it to hay or even to corn; but they are more fattened by it than fitted for labour; and they ought to receive it in combination with oats and good cut chaff, or with some other kind of nitrogenous provender. Mr. Youatt suggests that "if twenty pounds of furze are given to a horse, five pounds of straw, the beans, and three pounds of the oats may be withdrawn;" and Mr. Eddison of Gateford calculates that a single acre well cropped with furze will winter six horses.

The only practical difficulty in using furze as house or yard forage is so to bruise or destroy the prickles as to prevent them from hurting the mouth; and this difficulty can easily be overcome with the aid of machinery. A man, a boy, and a Highland pony may, with the use of a pair of old mill-stones and the simplest kind of straw-cutter, bruise and cut from 60 to 80 bushels a-day,—a quantity sufficient for 20 working horses; and in this case, the mill-stones require simply to be bolted together, and worked on edge in a circular trough of 14 feet in diameter, and to have an axle through their centre, and adjusted at the inner end to a strong post, and so mounted at the other end as to be attachable to the horse. Another method is to bruise and pound the furze by making a series of stampers fall upon it in a stone trough. A method used in Warwickshire is to propel a heavy cast-iron wheel, fluted in the circumference, round a circular stone or cast-iron trough; and this is sometimes preceded by cutting the furze into lengths, with a set of knives on the principle of the chaff-cutter, and then turning it into the trough. Various simple methods akin to the Warwickshire one consist in crushing the furze with different kinds of smooth or fluted rollers. An excellent machine on a large scale for cutting furze for the use of horses—though incompetent to bruise it or otherwise suitably prepare it for the use of cattle—was invented by Dr. Mackenzie of Kinallan in Ross-shire, and is modelled in the Highland Society's Museum in Edinburgh; it reduces a cart load of furze into fragments of from a quarter of an inch to a whole inch in length in the course of about 15 minutes; and it possesses the advantages of being workable by either water-power or hand-power, and of serving also as a straw-cutter, and in the latter capacity cutting about 13 cwt. of straw in 20 minutes. "This machine resembles, in every respect, the drum and feeding-rollers of the thrashing-machine. The drum is an open skeleton; and the four beaters, instead of being placed parallel to the axis, are curved and placed obliquely, each of the beaters being armed with a sharp-edged steel cutting-knife, as in the common straw-cutter. Immediately after the feeding-rollers, there is a square-edged steeled bar, the cutting-bar, firmly fixed to the frame-work; the cutters, in their revolution, pass in contact with this bar; and as the furze, in passing between the rollers, comes to rest on the edge of the bar, it is chopped off in very short lengths by a clipping action between the cutters and the bar. The feeding-rollers are the same as those of a thrashing-machine, the lower one carrying a pinion, which is driven by a spar-wheel, placed on the axle of the cutters. To insure the conveyance of the furze to the rollers, an endless web is kept in motion, in the position of the ordinary feeding-board, by means of a strap from the lower roller."—*Lawson's Agriculturist's Manual.—Marshall on Planting.—Transactions of the Highland Society.—Quarterly Journal of Agriculture.—Mill's Husbandry.—Society of Gentlemen's Complete Farmer.—Essays on Agriculture, Edin.* 1775.—*Doyle's Works.—Loudon's Works.—The Bath Papers.—Youatt on the Horse.—Catalogue of the Highland Society's Museum.—Knowledge Society's British Husbandry.*

FUSIFORM ROOT. A tap root, tapering root, or spindle-shaped root. Some of the minute fungi, particularly the genera *Fusisporium*, *Fusidium*, and *Fusarium*, have fusiform sporules; and some bulky agricultural and garden plants, particularly carrots, parsnips, beets, and some varieties of the brassica tribe, have large, fleshy fusiform roots.

FUSION. The reduction of a solid body into a fluid state by the application of heat.

FUSISPORIUM. A genus of minute mucedinous fungi, of the Coniomycetes tribe. Three species, of respectively rosy, whitish, and greenish-black colour, and all somewhat allied to the notorious genus botrytis, infest the first dry box leaves, the second decayed cucumbers, and the third decayed onions. The genus *Fusidium*, with whitish-coloured species which grow on fallen beech leaves and fallen oak leaves, is included by Hooker in the genus Fusisporium.

FUSTICK,—botanically *Maclura Tinctoria*. A beautiful, evergreen, economical, tropical tree, of the nettle tribe. It was ranked by Linnæus as a mulberry, and by Kunth as a broussonetia. It grows wild in the woods of the West Indies, and particularly of the Caribbee Islands; and furnishes the well-known fustick dye-wood of commerce. Its stem naturally rises to the height of 60 or 70 feet; its branches are numerous, and spread out on all sides; its bark is light brown, and has some shallow furrows; its leaves grow obliquely on short foot-stalks, have a roughness like that of common mulberry leaves, and are dark green in colour and about 4 inches in length; its flowers are apetalous, and grow at the ends of the young branches like pale herbaceous catkins; and its fruit are orbicular, about the size of nutmegs, and of a lusciously sweet taste. Small plants of fustick have, for upwards of a century, been occasionally cultivated in British hothouses. The wood of fustick is firm, compact, and of a bright yellow colour; it is imported principally from the Caribbee Islands; and it yields a fine golden yellow dye.

FUZZION. See Foissen.

G

GAD-FLY. See Bots.

GÆRTNERA. A genus of ornamental, evergreen, climbing, ligneous, tropical plants, of the Barbadoes-cherry family. Two species, the branchy or clustered and the obtuse-leaved, have been introduced to our hothouses from Hindostan and China; and both attain a height of about 15 or 20 feet, and carry whitish-coloured flowers.

GAGEA. A genus of hardy, ornamental, bulbous-rooted plants, of the asphodel family. It is nearly allied to the ornithogalums, but comprises only yellow-flowered plants.—The bundle-flowered species, *G. fascicularis,* called by some botanists *Ornithogalum luteum,* and popularly known as the yellow star of Bethlehem, is a very handsome indigen of some of the woods and shady pastures of Britain, usually having a height of 3 or 4 inches, and blooming in March and April.—The late species, *G. serotina,* called by some botanists, *Anthericum serotinum,* is an elegant native of some parts of Wales, has a height of 6 or 8 inches, and usually blooms in June.—Nearly twenty species, all spring-bloomers, and some very handsome, have been introduced from foreign countries, principally the middle regions of the temperate zone of the old world.

GAILLARDIA. A genus of hardy, perennial-rooted, herbaceous, ornamental plants, of the sunflower division of the composite order. Two species with orange-coloured flowers, and one with yellow flowers, have been introduced to our flower-borders from North America; and all are from 12 to 24 inches high, and bloom in summer and autumn, and have a coarsely showy appearance.

GAITING, or Gaitning. The setting up of wet or newly-reaped corn in single sheaves, in a loose and outspread manner. The band is tied immediately under the ears, and so loosely as to afford scope for a man's hand to be easily thrust down the centre of the sheaf; and the skirts are so twirled out as to give the sheaf the same outline and appearance as the straw cover of a hive. Sheaves set up in this manner are called gaits; they allow the wind to pass freely through them, and do not allow the rain to lodge; they dry corn much more rapidly than it could be dried in stooks; and when they have been overthrown or are exposed to a very strong wind, they may be made to support one another in groups of three. Gaiting is an excellent practice in a wet climate or unsettled and precarious season; yet it is safe or certainly profitable only with oats; for it is very liable to occasion the shaking out of the grains of wheat and the breaking off of the heads of barley.

GAITS. See Gaiting.

GALACTIA. A genus of ornamental, exotic plants, of the lotus division of the leguminous order. It has a close relationship to tares and hedysarums. Two hardy and two tender species, all red-flowered twiners of a yard or two in height, have been introduced to Britain; and upwards of a dozen more are known to botanists. The plants have the name of galactia from the milky appearance of their juice.

GALACTITES. A genus of hardy, ornamental, purple-flowered, annual plants, of the thistle division of the composite order. The woolly species, *G. tomentosa,* was introduced to Britain, upwards of a century ago, from the South of Europe; and was formerly ranked as a centaury. The name galactites alludes to the milky whiteness of the veins of the leaves.

GALACTODENDRON. See Cow-Tree.

GALACTOMETER. A small, narrow, graduated glass-tube, for ascertaining the per-centage of cream in any specimen of milk. A depth of 3 inches of the tube is divided into 100 parts; and the proportion of this depth occupied by the cream of new milk which has stood in it for the requisite length of time distinctly shows the per-centage.

GALANGALE,—botanically *Kæmpferia.* A genus of stemless, broadleaved, herbaceous, ornamental, tropical plants, of the ginger tribe. Eight species, all curiously beautiful and about a foot high, have been introduced to our hothouses from India and Malacca. The round-rooted species, *Kæmpferia rotunda,* is the longest and best known in Britain, and possesses considerable celebrity as a medicinal plant in India. Its root consists of fleshy tubers, which are sometimes jointed and about 4 or 5 inches long; its leaves are radical, caulescent, and about 4 inches long and 2 inches broad, and seem as if growing in pairs and spreading open each way; and its flowers grow singly among the bosoms of the leaves, and have a white colour with a bright purple bottom, and bloom in July and August. The whole plant is used for healing wounds and removing internal coagulations of blood; and the root is used as a sudorific, as a carminative, and for anasarcous swellings.—The galangale of commerce seems to be produced principally by *Kæmpferia rotunda, Kæmpferia galanga,* and *Alpinia galanga,*—the last also of the ginger family and close akin to the kæmpferias. "It consists," says Anderson, "of the greater and the lesser sort. The greater galangale is a knotty root, with several circles on the surface, of a reddish brown colour on the outside, and a yellowish white within, which greatly resembles ginger in its smell, taste, and chemical composition. The lesser, which is most esteemed, is a knotty, jointy root, about an inch long, and about half an inch thick, of a brownish red coat, pale red colour within, having several circular rings on the outside, of a hot, bitterish, aromatic, biting taste, like pepper, and a fragrant smell." Galangale root is given to horses by British farriers, as a carminative and a tonic, in doses of about an ounce.

GALANTHUS. See Snowdrop.

GALARDAI. See Gaillardia.

GALAX. A beautiful, hardy, leafless, perennial-rooted, herbaceous, North-American plant, of the saxifrage tribe. It constitutes a genus of itself. Its flowers have a milk-white colour, rise about 6 inches from the ground, and bloom in June and July.

GALAXIA. A genus of ornamental, bulbous-rooted, Cape-of-Good-Hope plants, of the iris tribe. Five or six species, all 6 or 8 inches high, and chiefly with purple or dark yellow flowers, have been introduced to Britain.

GALBANUM. A medicinal gum resin, obtained from a tender evergreen shrub, of the umbelliferous family. See the article Bubon. It appears to be produced in Persia and many parts of Africa, and is brought to Britain from the Levant. It has a consistency like wax, and is at first white but afterwards becomes yellowish or reddish; and it has a strong smell, and an acidulous, bitterish taste. It sometimes occurs in the shops in loose tear-like granules, or in masses of these granules agglomerated; but, in almost all such cases, it is mixed with many impurities; and it is always best in the form of ductile agglutinated masses, and of a pale brown or yellowish colour. It has stimulating, expectorant, deobstruent, and antispasmodic properties; and may be regarded as a medium medicinal power between ammonia and asafœtida, or as a kindred one to gum ammoniacum. Farriers administer it to the horse in doses of about six drachms.

GALE (Spleenwort-Leaved). See Liquidambar.

GALE (Sweet). See Candleberry Myrtle.

GALEANDRA. A genus of beautiful epiphytous, tropical plants, of the orchis tribe. The Duke of Devonshire's species, *G. Devoniana*, is a native of British Guiana, and first flowered in a British hothouse in 1840. It is a splendid plant, of a habit intermediate between the caulescent epidendra and cyrtopodium, with large round stems, elegant, half-drooping foliage, and upright racemes of large, elegantly-marked, and singularly imposing flowers. Bauer's species, *G. Baueri*, is also very beautiful. But the longest known species, *G. gracilis*, is comparatively shabby.

GALEGA. See Goat's Rue.

GALENA. The metallic ore which furnishes the pure metallic lead of commerce. It consists principally of sulphuret of lead, and is subjected, in a state of coarse powder, to the heat and action of a reverberatory furnace; and it undergoes a series of chemical transmutations which issue in the complete separation of its lead from its sulphur. But the lead obtained from it very commonly contains small proportions of silver, copper, and iron.

GALENIA. A genus of exotic plants, of the goose-foot tribe. The African species, *G. Africana*, was introduced nearly a century ago from the Cape of Good Hope, and is a curious, white-flowered, evergreen undershrub, of between 20 and 30 inches in height.

GALEOBDOLON. See Dead-Nettle.

GALEOPSIS. See Hemp-Nettle.

GALINSOGEA. A genus of plants, of the sunflower division of the composite order. The balbisia-like species, *G. balbisioides*, is a yellow-flowered, ornamental annual, of about two feet in height, introduced about 20 years ago from Mexico; and two other species have been introduced; and six or seven more are known.

GALIPEA. See Bonplandia.

GALIUM. See Bedstraw.

GALL. A blank in the interior of a field-crop.

GALL. An abrasion of a horse by the saddle or the harness. A galling from the saddle may be cured by a wash of water; common salt, and tincture of myrrh,—the salt in such quantity as to render the water decidedly saline, and the tincture of myrrh in quantity of about one-fourth of the water; and a galling from the collar or other part of the harness ought to be prevented, or may be healingly protected, by means of padding.

GALL. In the animal economy; the same with Bile, which see.

GALL. In natural history. Any protuberance or tumour produced by the puncture of insects on plants and trees of different kinds. Galls are of various forms and sizes, and no less different with regard to their internal structure. Some have only one cavity, and others a number of small cells communicating with each other. Some are as hard as the wood of the tree they grow on, others are soft and spongy. The first are termed *gall-nuts*, and the latter *berry-galls* or *apple-galls*. Oak-galls put into a solution of vitriol in water, give it a purple colour, which, as it grows stronger, becomes black; and on this property depends the art of making our writing ink and dyes. They are also powerfully astringent, and have a place in the materia medica; and though not often employed internally, they may sometimes, in doses of from two to four drachms, and in conjunction with other remedies, be advantageously administered in cases of obstinate diarrhœa in the horse.

GALL-BLADDER. A membranous reservoir, usually of the shape of a pear, or the size of a small hen's egg, situated in animals on the concave side of the liver. It lies upon the colon, part of which it tinges with its own colour. It is composed of four membranes, or coats—the common, the vesicular, the muscular, and the nervous one, which last is of a wrinkled or reticulated surface within, and furnished with an unctuous liquor. The use of the gall-bladder is to collect the bile secreted in the liver, and, mixing with it its own peculiar produce, to perfect it farther, to retain it a certain time, and then to expel it.

GALLERIA. See Wax-Moth.

GALL-FLY. The innumerable and curious excrescences which are seen on the leaves, branches and roots of trees, are all the productions of different kinds of insects. Some of these excrescences have within a single cavity, in which several insects live together. Others have a number of small cells, with communications between them; others again have numerous distinct cavities. These productions are of various sizes, form and consistence, some being spongy, and others, like the gall-nut, extremely hard. All these apparently monstrous productions are occasioned by the puncture of insects when depositing their eggs. The ancient opinion concerning the animals found in these receptacles was, that they were spontaneously produced from the rotten wood. Afterwards it was believed that the roots of plants had the power of sucking up, with the sap, the eggs of insects, and that these were animated as soon as they arrived in a proper situation. There are a multitude of insects which form these excrescences, the principal of which is the *cynips*. That which attacks the oak is of a burnished brown colour, with black *antennæ*, and chestnut-brown legs and feet. The wings are white. It is small and hymenopterous. The species of oak is shrubby, inhabiting Syria and Asia Minor. The excrescences are called *gall-nuts*. The insect is described and figured in Olivier's Travels, under the name of *Diplolepis gallæ tinctoriæ*. Like others of the genus, the female pierces a branch, and deposits an egg in the interior, around which, in the course of a few days, the excrescence is thrown out, affording nourishment to the young insect, and protecting it from external injury until it has attained its full size, when, after having undergone metamorphosis, it penetrates the sides of the excrescence, and comes out into the open air. The oak which bears the gall-nut of commerce, *Quercus infectoria*, does not attain a greater height than four or five feet, and usually has very numerous straggling branches. The leaves are oblong, sinuate, mucronate-dentate, and smooth on both sides. The acorns are elongated, and sessile or subsessile. The galls are hard, woody and heavy, about the size of a marble, usually round, and studded with protuberances. Those which are gathered before the departure of the insect are most esteemed, and have a bluish colour. The whitish are cheapest, and are sometimes dyed blue, but the deception may be detected by the hole made by the insect in its exit. Gall-nuts are powerfully astringent, and are frequently employed in medicine, as also in dyeing and making ink. An infusion is an excellent test of iron. They are imported from Symrna, Tripoli, and other places in the Levant, especially from Aleppo, to which place they are brought by the Koords from the western bank of the Tigris.

GALLIC-ACID. An acid obtained from gall-nuts, and from the bark of many tanniniferous trees. It probably exists ready made in the substances which yield it; and it is always associated, though nobody can tell how or why, with tannin. The principal barks which are known to yield it are those of the oak, the willow, the plum-tree, the poplar, the elm, the mountain-ash, the birch, the elder, the sycamore, the beech, and the cherry-tree. But it by no means follows the proportions of tannin; for it is nearly equally rich in about one half of these trees, and is comparatively abundant in them all. It is readily but very slowly obtained from a cold, long-kept, and eventually evaporated decoction of galls or of the tanniniferous barks; and it forms in small, white, acicular, silky-looking crystals, and has a weakly acidulous and slightly astringent taste. It forms very sparingly soluble salts, or gallates, with other bases than the pure alkalies; and possesses the power of precipitating many of the metallic solutions.

GALLINACEOUS FOWLS. An order, or very natural family, of land birds, represented by the domestic cock, and named from his scientific designation, *Gallus*. The gait of these birds is heavy; their power of flying is comparatively small; their bill is of moderate size, and has its upper mandible arched; their nostrils are partially covered by a soft and inflated scale; their toes, for the most part, are indented on the edges; their crop is very large, and their gizzard very powerful; their food, in general, is grain; and, with one exception, all lay and hatch their eggs on the ground, or on a slight carpeting of straw or grass. This order comprises the domestic cock, the pheasant, the capercailzie, the black-cock, the ptarmigan, the partridge, the quail, the pigeon, the turkey, the peacock, the guinea-fowl, and some others of less importance or not so well known.

GALLING. See Gall.

GALL-LAMB. A lamb which dies of bilious inflammation when about a fortnight old, or soon after it begins to graze. A lamb whose first grazings are upon rich pastures suffers distension of the stomach and accumulation of bile in the upper intestines, and sometimes dies after no more than 24 hours illness; and in allusion to the inflammatory action of the bile upon its system, it is popularly called a gall-lamb.

GALL-NUTS. See Gall.

GALLON. An English measure of capacity, both for dry and liquid articles. The standard bushel kept at the Exchequer for adjusting corn and beer measures, and bearing the date 1601, contains 270.4 cubic inches, or 156.25 ounces avoirdupois; while the Exchequer standard wine gallon, dated 1707, contains 230.9 cubic inches, or 133.4 ounces, the Excise wine gallon of 1798 contained only 230.1 cubic inches. By 5° Geo. IV. c. 74, the imperial gallon is declared to be the standard measure of capacity, and to contain 10 lbs. avoirdupois weight of distilled water at the temperature of 62°, the barometer standing at 30 inches, or 277.274 cubic inches; and all other measures of capacity for wine, beer, ale, spirits, and all sorts of liquids, as well as for dry goods not measured by heaped measures. Taking the old English wine gallon at its usual estimate of 231 cubic inches, the Imperial gallon is about one-fifth larger than the old wine gallon, or as 6 to 5 nearly; and taking the old ale gallon, which had gradually diverged from the wine standard, at 282 cubic inches, the Imperial gallon is about a sixtieth less than the old ale gallon, or as 59 to 60 nearly. The parts, or multiples, of the Imperial standard gallon are as follows:

5 oz. avoird. of water	=	1 gill	=	5-16ths lb. av.	=	8.6643125 cub. in.
4 gills	=	1 pint	=	1.25	=	34.65925
2 pints	=	1 quart	=	2.5	=	69.3185
4 quarts	=	1 gallon	=	10	=	277.274
2 gallons	=	1 peck	=	20	=	554.548
4 pecks	=	1 bushel	=	80	=	2218.192
8 bushels	=	1 quarter	=	640	=	17745.536

In heaped measure the Imperial gallon or half-peck must be 4 inches in depth; 9.39463 or 9⅜ inches in inside diameter; 9.75 or 9¾ inches outside diameter at the mouth; .17769 or $\frac{3}{16}$ of an inch breadth at the edge; and 3 inches in the height of the heap.

The old Scotch gallon, liquid measure, contained 827.232 cubic inches—or 4 quarts, or 8 standard pints of 103.404 cubic inches.

GALLOP. The most rapid pace of the horse. It is sometimes, though improperly, regarded as included in the amble or canter; and irrespective of this, it is of two kinds, the hand-gallop and the full-gallop.

The hand-gallop has an intermediate character between the amble and the full-gallop; and though apparently simple in its progress, is elaborate in its commencement. The horse simultaneously elevates his fore-quarters and throws forward his fore-legs; but he raises the right limb a little higher, and carries the right shoulder a little further forward than the left, so as to make the action, not a leap, but a pace. "During this first elevation, and in some instances preparatory to it, the right or off-hind foot moves slightly forward, but only sufficient to gain a true centre, and to correspond with the increased forwardness of the right shoulder: the near-hind leg, it must be remembered, yet remains fixed. The fore-extremities now reach the ground, the near-fore a little before its fellow, the off-fore doubling over it, and placing itself a little beyond it; and the slower is the gallop, the more considerable will be the distance between the placing of the fore-legs. As soon as the near-fore leg has met the ground, and before the off-fore has yet taken its full bearing, the hinder legs are moved in the following manner: the near-hind elevates itself; and, as it reaches the ground, the off-hind passes it, and becomes placed also. It is now that the horse begins to be 'all in air' in this pace; for on the next spring that the hind-quarters make, the fore-quarters being already elevated from the last impulse, the animal is, of necessity, completely detached from the ground." [Blaine's Outlines of the Veterinary Art.]

The full-gallop is a very simple affair, and consists merely in a succession of leaps. The fore-legs are thrown simultaneously forward; the hind-legs are quickly and almost simultaneously brought up; and the extension of all the limbs in the air during the interval between one bound and another, occupies vastly more time than the efforts of the leap. But the full-gallop requires so different a centre of gravity from walking, and demands so powerful and general a play of the muscles at its commencement, that it cannot be begun except through the medium of the hand-gallop, and always presupposes the acquirement of a momentum or a progressive increase of speed. "This fact," Mr. Blaine tells us, "is well known to jockies, and other sporting characters; and they often derive profit from the circumstance, by wagering with the unwary, that no horse shall be found to gallop 100 yards while a man runs 50, provided each start together; in which case, so much time is lost in acquiring the due momentum, that the man wins."

GALLOWAY. A horse or an ox of the Galloway breeds. See the articles HORSE and CATTLE.

GALLOWS. A part of a plough-head, consisting of three pieces, the one placed transversely over the other two. See the article PLOUGH.

GALL-STONES. See CALCULUS.

GALPHIMIA. A genus of ornamental, tropical, ligneous plants, of the Barbadoes cherry tribe. Two yellow-flowered species, the one an evergreen climber and the other an evergreen shrub, were introduced about 20 years ago from Mexico; and a number of other species are known.

GALVANISM. The evolution of electricity during certain chemical actions. It was accidentally discovered, in 1790, by Galvani, Professor of Anatomy at Bologna, in consequence of the exciting effect of a pair of scissors upon the limb of a dead frog; and it is usually obtained, in practice, by so arranging alternate pieces of copper and zinc in a weak dilution of sulphuric acid that the metals touch each other in one part, and are elsewhere separated by the fluid. The electricity evolved passes through the same substances as atmospheric electricity, and with the same facility and rapidity; it is educed by the play of chemical action between the metals and the dilution, and is positive as regards the zinc, and negative as regards the copper; and it may be led out to any point of application by means of wires, and can be obtained in either lesser or greater amount according to the power and volume of the excitants, and especially according to the number of their "circles" or alternations. A single circuit may be formed in various ways, but is always of very low intensity; a compound and very convenient circuit or "battery" in common use, consists of a series of alternations of small zinc and copper plates, attached to a transverse wooden bar, and a corresponding series of cells, with the diluted acid, in an earthenware trough; and the Royal Institution's great galvanic battery, by means of which Sir Humphrey Davy made his celebrated discovery of sodium and potassium as the metallic bases of the oxidal alkalies, comprises 2,000 pairs of plates each with 32 square inches of surface.

Galvanism acts as a stimulus on the living system; produces contraction of muscle and powerful spasmodic action in the bodies of recently dead animals; effects chemical decompositions of a more profound and difficult kind than can be achieved by any other known agency; has, of late years, been applied to some great and valuable economical purposes in the common arts; and affords some promise of working out remarkable results in the new and startling practice of electro-culture. See the article ELECTRICITY. Its history, too, is so curious and astonishing as mightily to suggest to farmers, gardeners, scientific experimentalists, and all other classes who enjoy extensive opportunities of observing the phenomena of natural agencies, the propriety of taking good note of every novel appearance which challenges their attention. "Who could have imagined it possible," exclaims Dr. Paris, "that the spasmodic action occasioned in the limbs of a frog, by the accidental contact of a pair of scissors, should have become the means of changing the whole theory of chemistry, of discovering substances whose very existence was never suspected, of explaining the anomalous associations of mineral bodies in the veins of the earth, of protecting surfaces of metal from the corrosive action of the elements, of elucidating the theories of volcanoes and earthquakes, and, may we not add, of leading the way to a knowledge of terrestrial magnetism? Such an unexpected extension of an apparently useless fact should dispose us to entertain a kinder regard for the labours of one another, and teach us to judge with diffidence of the abstract results of science. A discovery which may appear incapable of useful application to-day, may be our glory to-morrow: it may even change the face of empires, and wield the destiny of nations. The conic sections of Apollonius Pergæus remained useless for 2,000 years: who could have supposed that, after the lapse of 20 centuries, they would have formed the basis of astronomy?"

GAMBOGE. A medicinal gum-resin. The tree which produces it is called popularly the gamboge-tree, and botanically *Garcinia Gambogia*, and is a congener of the mangosteen, and a member of the guttiferous family. It ranks as a fruit-tree, is a tropical evergreen, and was introduced about 25 years ago from India to our hothouses. Its stem attains a height of about 30 feet, and is moderately branching; its leaves are opposite, ovate, entire, coriaceous, stiff, and obscurely green; its flowers are yellow, and partly mule, partly hermaphrodite; and its fruit is a smooth, globular berry, containing several triangular seeds. The gum-resin is obtained either by wounding the bark, or by breaking the leaves and the young shoots. It has an orange-yellow colour, and a vitreous fracture; and is opaque, brittle, inodorous, and nearly insipid. It stains the fingers with a brilliant yellow when wetted, serves as an excellent water-colour, and forms with alcohol a deep golden yellow tincture, and with water of potash or ammonia a deep orange-red solution. It acts medicinally on the human system as a powerful and dangerous drastic purgative; and though useful as an anthelmintic, and in dropsy and some other cases, requires to be used with extreme caution. It has been little used by veterinarians: yet is serviceable to the horse as an anthelmintic, and to facilitate the operation of aloes.

GAME. All wild birds and wild quadrupeds of Britain which the law allows to be captured or killed only at certain seasons and by licensed persons. The number and species of these have widely varied at different periods; and some have, for long periods, been game in one sense and not in another. The distinction between game and other wild animals, is altogether arbitrary; so that the definition of game is to be sought only in statutory law. See the article GAME-LAWS.

GAMEKEEPER. An official appointed by the owner or licensed possessor of the game of an estate or district, to act as conservator of the game. "A sportsman," remarks Mr. Daniel, "does not require a man to be termed a gamekeeper who is the best shot in the district; it is not for the purposes of slaughter but protection that he employs him; and to afford that protection, he should be well versed in the nature of every sort of vermin, with their haunts, their mode of preying upon the game, and not only know, but be indefatigable in catching, the most subtile and wary of them. He should be able to kill all vermin 'from a mouse to an otter, and from the eagle to a sparrow.' If with this art, he can shoot well enough to kill a dog or a hawk, his master will have a greater prospect of a stock of game than if he could hit eleven farthings out of twelve, thrown at several times into the air." "A gamekeeper," says the same writer, "should not be allowed to break any dogs but those of his master, or for his own immediate use; the birds will be quite enough disturbed in their pairing season with the hunting of them, without having a relay to break for strangers, to introduce still further confusion; neither should he be a frequenter of the alehouse." Some gamekeepers, particularly such as are prime marksmen, so enormously abuse their trust as to be wholesale poachers, and to maintain a connexion with the landlords of country inns and the guards of public conveyances for the illegal supply of game to town and city poulterers; and other gamekeepers, or rather gametakers, who are employed by gentlemen to shoot game by the number, are poachers upon neighbouring manors, and take whatever game they can get, irrespective of the legal territorial limits.

The laws respecting gamekeepers are properly a department of the game-laws, yet they may be stated more appropriately in this place than in the following article. A statute of Charles II. authorizes a gamekeeper to seize and destroy within the manor all instruments of capture or death belonging to unqualified persons, or to use all requisite means to protect game from poachers. A statute of Anne allows him authority from his master to kill game, but prohibits him from selling it without his master's consent; another statute of the same reign forbids more than one gamekeeper to be retained on one manor; and a statute of George I. requires that a gamekeeper shall be properly the servant of his employer, or shall be expressly retained to protect or to kill game for the sole use and benefit of his master. The present game-laws, as revised under William IV., authorize the appointing of a gamekeeper by writing under hand and seal, to protect and kill game within a manor, and to seize all animals and instruments of capture or death which may be used by unlicensed persons; and they also allow a gamekeeper to carry a gun anywhere out of the manor.

GAME-LAWS. Statutory enactments prohibiting the killing or capturing of certain wild animals, except within certain periods, and by licensed persons.

Every man, from the prince to the poorest peasant, has a natural right to pursue and capture for his own use any animal which flees from the dominion of man, or is not domesticated or tamed. This right was maintained by the Roman law, even down to the time of Justinian; it was recognised and acted on in all the early periods of British history; it figures as a principle of abstract or primary justice in some of the ablest legal writings, such as Blackstone's Commentaries, which propound and advocate the game-laws; and it was subverted in Europe only by the enslaving power of the feudal system, and is prevented from resuming its ascendancy only by mistaken and exceedingly mischievous notions of social policy. "The game-laws," remarks Daniel, "were introduced among us at an era when property was not governed, either in the use or in the possession, by those enlightened maxims of justice which at present secure it. The aristocratic orders of that period consulted their own amusement and pleasure, without any very scrupulous regard to the rights, or very provident care for the comforts, of the least opulent but not least valuable classes of the community. They were strong, and they were not willing to weaken the foundation of their power, by a relaxation of their privileges. Their pride made them averse from sharing with the commonalty an amusement which, by a small stretch of power, they might appropriate to themselves. The exercise of hunting, and the pursuits of the various sorts of game, partaking somewhat of that spirit of enterprise in which they delighted, were recreations of all others congenial to their taste; it is not therefore wonderful that they should contrive to debar the lower orders from their participation."

The natural right of every man to capture wild animals was originally assailed, not by reasoning, or jurisprudence, or legislation, but by sheer usurpation and tyranny. The barons or land-owners of the ages succeeding the Roman, simply took advantage of the high power which they possessed on their respective estates, or within their respective territories, to claim all wild animals, or as many species of them as they pleased, as exclusively their own, and to prohibit all their serfs and other underlings from meddling with them on pain of certain penalties; and, owing to the peculiar circumstances of the times, they had ample means, not only of enforcing their usurpation themselves, but of procuring formal sanctions of it from the supreme authorities of states. A law, accordingly, was made by Canute, and confirmed by many succeeding kings of England, declaring every gentleman to be the proprietor of beasts of chase and birds of sport found upon his own estate,—"quilibet homo dignus venatione sua, in sylva et in agris sibi propriis et in dominio suo;" and a continuous stream of assertions and assumptions, to the same effect, runs through the common law of England, and through comparatively modern dissertations and decisions on the subjects of sporting and hunting.

The grounds for the game-laws, asserted by Blackstone and other high legal authorities, are widely different from those of their real origin and early character. Blackstone contends that, from the very design and constitution of society, the natural right of every man to hunt wild animals, may, in common with many other natural rights belonging to men as individuals, be restrained by positive laws, enacted for reasons of state, or for the supposed benefit of the community; he maintains, also, both upon the principles of the feudal law and upon a prominent maxim of the common law, that wild animals belong to the king by his prerogative as the ultimate proprietor of all the lands in the kingdom; and he concludes that the game-laws are consistent with sound policy and with the true interests of society, and that a violator of them, not only transgresses just statutory enactments, and incurs all the aggravations which the conditions of the enactments may involve, but is guilty of encroaching on the royal prerogative. We reserve a remark or two on the alleged justice and policy of the laws to a subsequent part of this article; and may here simply observe, that the royal prerogative seems to be as seldom adverted to by the convictors of poachers as by poachers themselves; that this alleged prerogative is not recognised by the constitutional law of England, and is thoroughly though not formally opposed by the express terms of some particular statutes; and that all the practical tendencies of the laws, in every age down to the present day, render the pursuit of game as truly and strictly an arbitrary privilege of the aristocracy as in the original usurpation of it by the feudal barons.

The game-laws, as they existed previous to 1831, were exceedingly numerous and intricate, and were aggregately beset with incongruities and shrouded with obscureness; and though many were repealed, and the rest modified, harmonized, and amended by a great act passed in that year, a few specimens of them, whether in their annulled or in their merely altered portions, may here be advantageously quoted for sake of their historical connexion with rural interests.

The earliest recorded qualification relating to game was enjoined by a statute of the 13th year of Richard II., which enacted, "that no manner of artificer, labourer, or any other layman, who hath not lands or tenements to the value of ten shillings by the year, nor any priest nor other clerk, if he be not advanced to the value of ten pounds by the year, shall have or keep from henceforth any greyhound, hound, or other dog to hunt, nor shall use ferrets, hays, nets, &c. to take or destroy deer, hares, nor conies, nor other gentlemen's game, upon pain of one year's imprisonment." But the qualification of more modern times, extending down to the modification of the whole system in 1831, was enjoined by a statute of the 22d and 23d years of Charles II., which enacted that every person not having lands or tenements or some other estate of inheritance, in his own or his wife's right, of the yearly value of £100 for at least the term of his life, or not having a lease-hold of the yearly value of £150 for at least 99 years, or not being the owner and keeper of a forest, park, chase, or warren, or not being the son and heir-apparent of an esquire or of some person of higher degree, is prohibited from possessing or using any appliances, whether mechanical or animal, for taking or killing conies, hares, pheasants, partridges, or other game.

A clause in the annual mutiny act, besides exemplifying the rigorous spirit which enacted most of the penalties for illegally catching game, assumed and enforced the extraordinary principle of punishing one man for the deed of another; for it enjoined that any soldier convicted of unlawfully catching or destroying any hare, coney, pheasant, partridge, &c., should forfeit five pounds to the poor of the place, and that the chief commanding officer over the soldier should forfeit twenty shillings, and, on neglecting to pay that forfeit within two days should be deprived of his commission. One principal game-law statute, passed in the 4th and 5th years of William and Mary, enacts that the house of any suspected and unqualified person might be forcibly entered by warrant from a justice of the peace,—that, in case of any "hare, partridge, pheasant, pigeon, fish, fowl, or other game" being found in it, the inhabitant be carried before a justice,—and that if he cannot clear himself from the charge of killing the game, he shall pay a fine of from 5 to 20 shillings for each of them, or shall be committed from 10 to 31 days to the house of correction, there to be whipt and kept at hard labour. Another principal statute, passed in the 5th year of Anne, enacts that any unqualified person who may be convicted before a justice of keeping or using any dog or engine for killing game, shall forfeit £5 or be committed for three months to the house of correction. Another principal enactment, passed so recently as the 9th year of George IV., but breathing the spirit of the most crushing period of the feudal times, enacts—we quote from Archbold—"that if any person shall, by night, unlawfully take or destroy any game or rabbits in any land, whether open or enclosed, or shall by night unlawfully enter or be in any land, whether open or enclosed, with any gun, net, engine, or other instrument, for the purpose of taking or destroying game, such offender shall, upon conviction thereof before two justices of the peace, be committed for the first offence to the common gaol or house of correction, for any period not exceeding three calendar months, there to be kept to hard labour, and at the expiration of such period shall find sureties by recognisance, or in Scotland, by bond of caution, himself in ten pounds, and two sureties in five pounds each, or one surety in ten pounds, for his not offending again for the space of one year next following; and in case of not finding such sureties, shall be further imprisoned and kept to hard labour for the space of six calendar months, unless such sureties are sooner found; and in case such person shall so offend a second time, and shall be thereof convicted before two justices of the peace, he shall be committed to the common gaol or house of correction for any period not exceeding six calendar months, there to be kept to hard labour, and at the expiration of such period shall find sureties by recognisance or bond, as aforesaid, himself in twenty pounds, and two sureties in ten pounds each, or one surety in twenty pounds, for his not so offending again for the space of two years next following; and in case of not finding such sureties, shall be further imprisoned and kept to hard labour for the space of one year, unless such sureties are sooner found; and in case such person shall so offend a third time, he shall be guilty of a misdemeanor, and, being convicted thereof, shall be liable, at the discretion of the court, to be transported beyond the seas for seven years, or to be imprisoned and kept to hard labour in the common gaol or house of correction for any term not exceeding two years; and in Scotland, if any person shall so offend, a first, second, or third time, he shall be liable to be punished in like manner as is hereby provided in each case."—Any persons, whether qualified or unqualified, found exposing to sale any hare, partridge, pheasant, or other game, either forfeited £5 or was liable to three months' imprisonment; and any victuallers, inn-keepers, or other such persons having game in their possession, unless sent to them by some gentleman legally qualified to kill it, incurred, on account of every individual animal of it, the same punishment as if he exposed it to sale.

These laws will excite the astonishment and horror of future ages; for, besides being combined with numerous other statutes which wrapped their meaning in obscurity and doubt, and rendered a knowledge of them almost unattainable by multitudes of the very class of the community whom they most deeply affected, they violently outraged the natural rights of the great body of the people, invested the wealthy with a power of dreadful oppression over the industrious, and inflicted penalties so inordinately severe as to confound all distinction between venial trespass and public crime, or between mistaken apprehension and flagrant vice. "That these laws," remarked Daniel in 1807, "should originally have crept into our code, as they did, at a period when the rights of the subject, being neither greatly regarded nor well understood, were without much ceremony fettered with restrictions, is not surprising; but that they should be suffered to reproach our statute-book in an age when freedom, refined by science, boasts the enlargement of her empire,—when the political and moral rights of all orders of men are submitted to the test of reason and the touchstone of philosophy,—that at such a period the spirit of hardship and injustice should so conspicuously display itself, reflects a dishonour on our constitution, from which its considerate advocates must most ardently wish it relieved."

The new game-law of 1831 repealed about thirty previous statutes, reduced the subject within somewhat practicable limits, removed doubts and ambiguities, and materially lessened the severity of the system; yet it substantially perpetuates the whole of the oppression, and continues to impose an arbitrary and galling yoke upon the industrious portions of the rural community. Game now includes hares, pheasants, partridges, moor-game, black-game, and bustards. The killing of game by any person on a Sunday or on Christmas-day, incurs a penalty of £5; and a partridge may not, without the like forfeit, be killed between the 1st of February and the 1st of September; nor a pheasant between the 1st of February and the 1st of October; nor black-game, in Somersetshire, Devonshire, and the New Forest, between the 10th of December and the 1st of September,—and in other districts, between the 10th of December and the 20th of August; nor grouse or red game, between the 10th of December and the 12th of August; nor any bustard between the 1st of March and the 1st of September. The laying down of poison to kill game incurs a penalty not exceeding £10; and the possessing of any one head of game by a licensed dealer later than 10 days after the expiry of the legal period for killing it, or by any other person later than 40 days, incurs a penalty not exceeding £1. But special and entire exceptions are made in favour of landowners and of gamekeepers and others holding annual certificates. A landowner who, in his agreements with his tenants, reserves to himself the game upon his estate, has a right to pursue and kill it on any part of the land, and may give the same right to any certificated persons. A tenant whose lease contains no covenant respecting game, may kill it, but is liable to be fined; and a tenant, whose lease reserves it to the landlord, and who does not obtain from the latter express leave to pursue it, incurs a fine of £2 for every act of pursuit, and a fine of £1 for every head of game he kills or captures, and also, in each case, the costs of prosecution. Every person holding a game certificate on an annual duty of £3 13s. 6d. may sell game to a licensed dealer; and every dealer in game must hold a license on an annual duty of £2. "And whereas, after the commencement of this act," says the statute, "game will become an article which may be legally bought and sold, and it is therefore just and reasonable to provide some more summary means than now by law exist for protecting the same from trespassers,"—then follow enactments in the same spirit of severity, and very nearly the same in substance, as those crushing ones which were made in the 9th year of George IV., and which we have already exhibited at full length,—while these very Georgian enactments themselves are made to continue in their pristine force in Scotland; so that the relaxation of the old laws to the extent of permitting a limited, licensed, and hesitating traffic in game, is only made the occasion for excusing and strengthening the rigorous spirit of the whole game-law system, and for re-enacting some of its severest penalties. Trespassers in search of game by day are subject to a fine of £2,—or if they be five in number, to a fine of £5; and armed trespassers in search of game by night, or at any time between an hour after sunset and an hour before sunrise, are indictable for a misdemeanor. A penalty of 5s. per egg is exigible, also, for all the eggs of game-fowls, swans, wild-ducks, teals or widgeons, which either are destroyed or may be found in a house.

The game-laws, then, in even their amended form, are quite akin in both spirit and tendency to the oppressive game-laws of the olden times, and must be regarded as grievous to the landed tenantry, impolitic to the landed gentry, and prejudicial to the whole community.

Blackstone alleges that the game-law system, by giving every man an exclusive dominion over his own land, encourages agriculture and georgic improvement. But if the exclusive right of killing pheasants and partridges be requisite to dominion over the lands of a farm, the exclusive right of killing rats and mice must be requisite to dominion over the buildings of a farmery; and if the restraining of a tenant from meddling with pheasants and partridges, or with the eggs of teals or widgeons, can promote the good cultivation of the soil, the restraining of him from meddling with rats and mice, or with the ovules and larvæ of destructive insects, ought also to promote the proper management of the farm-yard. The dominion which the game-laws give a landowner over the soil, is not a dominion of patronage, or encouragement, or assistance, or legislation,—or a dominion of mind, or of knowledge, or of silent majesty; but it is an arbitrary, physical, and uncompensating control over some of the productiveness of the land,—a sheer power of intrusion and encroachment,—a right of giving some disturbance and trouble in person, and of authorizing the same to be given by others. Other varieties of dominion over the soil, quite as distinct and far more powerful, such as restriction in the use of certain manures, prohibition from breaking up grass lands, and the inculcation of a certain and uniform rotation of crops, are maintained throughout many estates, in virtue of express covenants in leases; and these might easily be so extended and multiplied in theory as to reserve to the landlord all control over soil and produce, and to make over nothing to the tenant but an empty name; but, so far from encouraging agriculture, they encumber and embarrass it,—and in the exact degree in which they reserve dominion to the landlord, they enfeeble and cripple an intelligent tenant, and detract from the intrinsic value of his farm, and prevent him from either improving the soil or contributing to the national wealth. Yet a tenant knows the precise limits of these instruments of dominion, and has voluntarily subjected himself to them, and can calculate the amount of produce which they will prevent him from realizing; but he has had no option respecting the game-law instrument of dominion, and knows not how many intrusions and interferences it may make upon his grounds, and cannot guess whether he will be annoyed most by an excess of game infesting his fields, or by an excess of sportsmen pursuing the game.

Another reason assigned by Blackstone for the game-laws, is that they preserve the several species of game from being extirpated by a general liberty. But this reason powerfully, though tacitly and indirectly, contradicts the preceding one; for it assumes that the wild animals designated game, as well as the larger wild animals not so designated, are liable to be completely driven before the onward march of society, and to be utterly exterminated by the progress of the arts of social life; and it, therefore, concedes that the forcible or statutory conservation of game opposes the true interests of the aggregate community, and acts, in particular, as a check upon the sweeping power of thorough agricultural improvement. If the unrestrained development of social energy, called ambiguously by Blackstone "general liberty," and involving the modification or removal of every natural hinderance to the thorough prosperity of agriculture and the other arts of civilized life,—if this tend to extirpate the hare and the partridge and other game, as certainly as it tends to extirpate the wolf and the fox, then the principle of protecting game by statute law is the same in kind, quite as unjustifiable and essentially as foolish, as would be the principle of legally protecting the wolf and the fox.

A third reason assigned by Blackstone for the game-laws, is the prevention of idleness and dissipation in husbandmen, artificers, and others of lower rank, which would result from universal license. But if it be a good thing for gentlemen to pursue game, how comes it to be a bad thing for husbandmen and artificers to pursue it? or are idleness and dissipation irreproachable qualities in landlords, and vicious qualities in tenants? or do squires and noblemen and certificated gentry take upon themselves the whole care of game, and go through the toil of pursuing and killing it, just that they may shield yeomen and ploughmen from temptation to vice? or can all the alleged idleness and dissipation which would have resulted from universal license, bear a moment's comparison with the torrents of demoralization and misery which have continuously issued from all sorts of violations of the game-laws, between the pettiest infractions and the most systematic poaching, and swept across the whole surface of rural society? Besides, if, according to Blackstone's second reason, an universal license would speedily extirpate game, the very best method of putting an end to all the alleged temptations to idleness and dissipation, would just be to give that license, when the evil would soon and for ever cure itself.

A fourth reason assigned for the game-laws—and said to be a reason oftener meant than avowed by the abettors of these laws—is the prevention of popular insurrections and resistance to government by disarming the bulk of the people. But the people can keep many formidable weapons in spite of the game-laws; and some might clandestinely keep prohibited weapons out of mere irritated feeling, who would never think of keeping them under universal license; and few or none could learn from the peaceable pursuit of game any rudimental knowledge of military science; while many unavoidably acquire, from systematic violation of the game-laws, both a daringness of disposition and an expert use of fire-arms which may render them truly dangerous. Nor during all the periods of the game-law system preceding the invention of gunpowder, do statesmen and barons ever seem to have contemplated the disarming of the peasantry as either an object or an effect of the game-laws; for, in those times, hawks were chiefly used for killing birds, and hounds and nets for killing quadrupeds, and neither hawks nor hounds were in any risk of being used as ancillaries of sedition.

A fifth reason for the game-laws—though not assigned in the same formal manner or by the same professional class of writers as the preceding four—is the policy of alluring the landed gentry to reside in the country, by the provision of a fascinating and aristocratic amusement. "If the game-laws may be regarded as somewhat favouring the propensities of the upper ranks," says a writer who, on almost all other grounds, condemns these laws, "their policy may not be in this respect greatly erroneous. There is a selfishness in insisting, that no laws ought to accommodate themselves to these propensities. The very station of such persons excludes them, in great measure, from such diversions as make part of the recreation of the lower classes. That the same partial spirit which may be deemed to distinguish the game-laws, should pervade and quicken our whole legal system, is not a thing to be wished; but when, as in the present instance, the resulting consequences are not evil, to call towards them that feverish spirit of discontent, which tends to extinguish the social character of man in civil community, is neither liberal nor wise. If these laws answered only this one end, the inducing persons of rank and property to reside more on their estates, by securing them a local amusement suited to their inclination and taste, this alone ought to weigh much in conciliating our approbation towards them. A sensible modern writer, remarking on a district in Yorkshire, where the landed proprietors chiefly reside on their estates, observes, that 'the good effect of this are everywhere visible in the improvement of agriculture, in the repair of the roads, in the administration of justice, and in the good order, comfort, and general happiness of the people.' Whatever tends to counterpoise the attractions which, in the progress of opulence and refinement, the metropolis of a great kingdom everywhere presents, ought not on slight grounds to be discouraged. The true strength and greatness of a state are in proportion to the virtue of its subjects; the empire of virtue is extended by whatever weans the inclination from pursuits by which the mind is contaminated and debased; the sports of the field contribute to this effect, and more particularly among those whom such pursuits are most likely to solicit with effect; and to these, therefore, they are with reason more exclusively reserved." But if, according to a former reason, the pursuit of game induces idleness and dissipation, it can only debase the landed gentry and unfit them for their duty to their tenantry; or if, according to the present reason, it contributes to elevate public morals and to extend the empire of virtue, it ought, in all sound policy, as well as on every principle of justice and benevolence, to be conceded as freely to the great bulk of the people as to the upper ranks. The stated residence of a landowner on his estate, though naturally fitted to confer great benefits on his tenantry, and though generally a duty obligatory upon him to society, is not, in every instance, beneficial, but may, through the perversities of his character, be transmuted into a source of great, positive, and manifold evils; and whenever the attachments of a landlord to the country are so feeble in power, so gross in nature, so limited in range, and so wofully destitute of all sense of proprietorial responsibility, of all patriotism, of all feelings of justice to his people, and of all enlightened regard to the interests of agriculture, that the mere exclusive right to pursue and kill game shall draw him away for a season from the whirl of fashionable life in the metropolis, we have too serious cause to apprehend that his presence in the country is quite as likely to do harm as good. See the article ABSENTEEISM. As to any district either in Yorkshire or anywhere else, where landlords and farmers live together in the mutual discharge of duty and the common enjoyment of prosperity, the very residence of the former, and still more the benign influence which attends it, must be ascribed to attractions and excellencies, not arising from the exclusive pursuit of game, but existing in spite of it.

A sixth reason for the game-laws—somewhat akin to the preceding one, but far more subtle and imposing—is an alleged exclusive right to the game of a cultivated country, founded on the circumstance of their being fed by the produce of land. "In a highly cultivated, well-peopled country," it is said, "no animal can properly be considered as wild. All are supported by the property and labour of those who cultivate the soil. Some from their peculiar instincts, are, indeed, less capable than others of being entirely appropriated, and therefore, like lands uninclosed, are held as a joint property. But he who has no land, and consequently contributes nothing to their maintenance, is no more entitled to any use of them, than the inhabitant of one parish is to a right of commonage on the waste lands of another; and he who chooses to reside in a town, and to keep his property in money, has no more a pretence to seize to his own use a hare or a partridge, than a sheep or a goose, from him who has chosen to vest his property in land. In the former, as in the latter case, he ought to tempt the owner to sell what is wanted." This argument, be it observed, refers to "a highly cultivated, well-peopled country," or to the ordinary conditions of general farming and cultivation under which most of the game of Britain occur; so that it affects, not landlords merely, but very specially all cultivators of land, whether capitalists or labourers, and likewise all who have a money interest in the land's produce. If game, like the deer of parks, were wholly supported within uncultivated enclosures, they might truly be regarded as the exclusive property of the parties to whom the enclosures belonged; but since they are supported on lands on which the farmer has lavished both his capital and his care, and on which the farm-workman has expended his productive labour, and to which the village-artisan and the city-merchant look for the returns of food which they have tacitly bargained with the rural community to receive in exchange for their village and city productions, the game, according to the very principles of the argument itself, must clearly belong in the first instance to the farmer, in the next to the farm-labourer, in the next to other productive classes of the community, and last of all, to the landlord,—who, in many an instance, is the mere passive proprietor of the land, and adds nothing, either directly or indirectly, to its productiveness.

We sum up our observations on the game-laws in three clauses,—they violate the natural right of man, they rest on a basis of political injustice, and they mar the loyalty, contentment, and general good feeling of the great bulk of the community; and we shall illustrate these by a brief quotation from the very writer who states and argues the fifth of the reasons noticed by us in defence of the game-laws:—"No right which Nature has bestowed ought to be circumscribed in its enjoyment, merely by the will of those who rule. We are told, indeed, 'that in these prohibitions, arising out of the game-laws, there is no natural injustice, as some have weakly enough supposed, since, as Puffendorf observes, the law does not hereby take from any man his present property, or what was already his own, but barely abridges him of one means of acquiring a future property, that of occupancy,—which indeed the law of nature would allow him, but of which the laws of society have in most instances very justly and reasonably deprived him.' Even the concurrent testimony of such justly valued authorities as Blackstone and Puffendorf, cannot reconcile to our reason a principle so directly adverse to every axiom on which the equal liberty of man is founded. The laws of society can in no instance justly and reasonably deprive mankind of any one right which Nature would allow them. This position annulled, all our natural liberties are annihilated. At once to value those liberties as sacred, and to hold such a position as orthodox, is utterly impossible. I confess that I always suspect a fallacy in that reasoning, from whatever quarter, or from however renowned an authority, which tends to shake the basis of the natural, or what is the same thing, the just and moral freedom of man. The consequences involved in the above doctrine are too important to escape the observation of reflective minds.* * The laws for the preservation of game certainly depart more widely from the line of genuine political justice, and expose the humble unqualified classes of the community more to the hazard of punishment, and the oppression of power, than any rational advocate of moral equality can consistently approve. * * That the act of destroying game is not *malum in se* is evident; for if it were, the legislature could not license it. Not only the want of true wisdom, but the want of common justice in these statutes, requires the most earnest and attentive consideration in those who administer in the government of the state. Every amendment, however minute, in the defective part of its legislative system, is an immense acquisition of strength to our constitution. It takes a weapon from the armoury of its enemies, and knits more closely the union of its friends. Unwise laws are the worst foes of a state. The public statutes should perpetuate and keep alive the great principles of practical freedom."

GANG. A course or slip of the thatching of a house.

GANGLION. A tumour upon a tendon or muscle, or a knot in the course of a nerve. The ganglia of the nerves of the horse have a greyish colour, are exceedingly various in form and size, and occur chiefly on the larger nerves of involuntary motion. The bundles of nervous filaments in a large ganglion first separate and then reunite; but those of a small ganglion are too minute for observation. "As nerves of involuntary motion, and such as are particularly destined to general sensibility," remarks Mr. Delabere Blaine, "are those which principally arise from ganglia, so we are led to conjecture that they are destined to place the nerves they belong to out of the control of the will, as well as to furnish fresh relays of nervous energy, which, it is remarkable, become, by their means, probably incapable of fatigue or exhaustion. Thus the horse of thirty continues to respire with equal ease as he did at five, unless his lungs have become disorganised; neither by any act of his will, is he capable of stopping the respiratory inhalation. The nerves of sense are five or six times larger than nerves of motion, which was necessary, as well from the importance of their office, as that they receive in general no accession of vigour from ganglia." Similar remarks might be made upon the ganglionic system of other vertebrated animals. But in the case of insects, a series of ganglia with their connecting filaments, situated consecutively in head, thorax, and abdomen, perform offices corresponding, not only to those of the nerves of involuntary motion in vertebrated animals, but to those also of the other nerves, and even to those of the brain. The ganglia of the several segments of insects generally ramify their own departments, and at the same time are but slightly connected with one another; and hence, not only the diffusiveness and comparative obtuseness of sensation in insects, but the power of motion which one segment of a wasp or other insect retains for a considerable time after its separation from the other segments.

GANGRENE. A disease in the bulbs, the young shoots, the leaves, the flowers, and the fruit of many plants. A dry gangrene attacks the bulbs of saffron, the young plants of the potato, and the shoots and green foliage of some other plants, and causes them to shrink, shrivel, blacken, and perish; and this is caused, in the case of the saffron bulbs, by parasitical fungi of the Lycoperdon tribe,—in the case of the potato, by morning frosts,—and in the case of other plants, by either excessive cold or excessive heat. A wet gangrene attacks leaves, flowers, and fruits, and causes them to become successively soft, moist, and ichorous; and this may arise either from contusion, from excessive moisture, or from a plethoric habit in the plant.

GANGRENE. A putrefying state of an organ or part of a diseased animal. It is the same as sphacelus or mortification; constitutes the last stage of the most violent kind of local inflammation; arises from the rupture of the local blood-vessels by the congestive action of the inflammation; and consists in the decomposition of the effused blood and the ruptured tissues. The discharge from a gangrenous organ is dark-coloured, and has a peculiar and very offensive smell; and the attendant symptoms indicate sinking, debility, and excessive danger. Gangrene in any important organ is incurable; but external gangrene arising from a wound or a contusion may, in the case of the horse, be successively scarified, fomented, and dressed with digestive liniment, oil of turpentine, or camphorated spirit of wine.—Epidemic pneumonia in cattle, ending in congestion of the lungs, and in internal effusion of blood, was formerly, but somewhat incorrectly, called gangrenous inflammation of the lungs.—Dreadful diseases, of the appearance of gangrenous epidemics, have occasionally prevailed among the human population of some districts of Europe, in consequence of the use of ergotted rye. See the article ERGOT.

GAP. A breach or opening in a fence. This name is sometimes applied also to any partial disruption in the internal organism of a plant.

GARCINIA. See MANGOSTEEN and GAMBOGE.

GARDEN. A piece of ground laid out for the careful cultivation of fruits, flowers, and kitchen vegetables.

Situation, &c.—The consideration of the position of the garden with respect to the mansion-house properly belongs to the subject of LANDSCAPE GARDENING: which see. It may only here be remarked that of late it has become fashionable to place the fruit and kitchen-garden at perhaps half-a-mile's distance or more from the house In many cases this has been found inconvenient. It can seldom happen that the garden-walls may not be effectually concealed, by means of shrubs and low growing trees, so as not to be seen at least from the windows of the public rooms, and the garden yet be situated much nearer to the house. It is scarcely necessary to observe, that an access for carts and wheel barrows, without touching the principal approach, is indispensable. Some of the circumstances which are considered as constituting the best kind of situation may here be mentioned, and these, it may be remarked, ought never to be altogether sacrificed to effect.

Shelter is, in our climate, a primary consideration. This may in part be derived from the natural shape and situation of the ground. Gentle declivities at the bases of the south or south-west sides of hills, or the sloping banks of winding rivers with a similar exposure, are therefore very desirable. If plantations exist in the neighbourhood of the house, or of the site intended for the house, the planner of a garden naturally looks to them for his principal shelter; taking care, however, to keep at a reasonable distance from them, so as to guard against the evil of being shaded. If the plantations be young, and contain beech, elm, oak, and other tall-growing trees, allowance is, of course, made for the future progress of the trees in height. It is a rule, that there should be no tall trees on the south side of a garden, to a very considerable distance; for during winter and early spring, they fling their lengthened shadow into the garden, at a time when every sun-beam is valuable. On the east also they should be sufficiently removed to admit the early morning rays. The advantage of this is conspicuous in the spring months, when hoar-frost often rests on the tender buds and flowers: if this be gradually dissolved, no harm ensues; but if the blossom be all at once exposed to the powerful rays of the advancing sun when he overtops the trees, the sudden transition from cold to heat often proves destructive. On the west, and particularly on the north, trees may approach nearer, and be more crowded, as from these directions the most violent and the coldest winds assail us. If forest-trees do not previously exist on the territory, screen plantations must be reared as fast as possible. The sycamore or plane-tree of Scotland, is of the most rapid growth, making about six feet in a season; next to it may be ranked the larch, which gains about four feet; and then follow the spruce and balm-of-Gilead firs, which grow between three and four feet in the year. Walls and quick hedges are subordinate means of shelter, to be spoken of by and by.

The best general *exposure* for a garden must evidently be towards the south; and a gentle declivity in that direction, equal perhaps to a fall of one foot in thirty, is deemed very desirable; effectual draining being in this case easily accomplished.

Water is not to be forgotten. If a streamlet can be brought to flow through the garden, it may be rendered conducive both to convenience and amenity. Where this cannot be accomplished, the situation should be such that water may be conveyed by pipes from some neighbouring stream; soft or river-water being greatly preferable, for the purposes of the horticulturist, to that of springs or wells. Where running water cannot be commanded, recourse is had to a lake or pond, it being known that water freely exposed to the air and sunshine for some time, becomes comparatively soft, and fit for the nourishment of plants.

In selecting ground for a garden, the plants growing naturally on the surface should be noted, as from these a pretty correct opinion may be formed of the qualities of the *soil*. The *subsoil* should also be examined. If this be radically bad,—such as an iron-till mixed with gravel,—no draining, trenching, or manuring will ever prove an effectual remedy; if, on the contrary, the subsoil be tolerably good, the surface may be greatly meliorated by these means. In every garden, two varieties of soil are wanted,—a strong and a light one,—or, in other words, a clayey loam and a sandy loam,—different plants requiring these respective kinds. For the general soil, a loam of middling quality, but partaking rather of the sandy than the clayey, is accounted the best.

Enclosure Walls.—When the situation is fixed on, the next consideration is the enclosing with walls. Supposing a garden to be about an acre in extent, and the ground sloping gently to the south, the rule is, that the north wall may be 14 feet high; the south wall, 10; and the other walls, about 12. In a larger garden, containing perhaps four acres, the north wall is sometimes raised 18 feet high; the side walls, or those on the east and west, 15; and the south wall, not more than 12. On a dead level the north wall is generally made 16 feet high; the east and west walls 13½; and the south wall, 11. It may be observed, that walls higher than 12, or at most 14 feet, are necessary only for pear-trees; peach, nectarines, apricot and plum-trees seldom requiring more than 12 feet. It may also be right to notice, that the terms north and south wall are here used to denote the north and south sides of a square or parallelogram; but that, in speaking of wall-fruit, if it be said that peach or fig trees require a south wall, this must be understood to mean a wall with a south aspect, or what is in reality the north wall of the garden. There are two motives therefore for raising this wall some feet higher than the others; first, sheltering the garden from the northern blast; and, in the next place, the procuring of ample space for training the finer kinds of fruit-trees on the south side of the wall, or best aspect of the garden. Many gardeners are of opinion that the best aspect for a fruit-wall in this country is about one point to the eastward of south; such walls enjoying the benefit of the morning sun, and being turned a little from the violent west and south-west winds. South-east is, for the same reasons, accounted by many a better aspect than south-west. The south-west and west walls are assigned to fruits which do not require so much heat to ripen them as is necessary to those above mentioned; such are cherries, many kinds of pears, and apples. The north walls are appropriated to apples and pears for baking, plums and morella cherries for preserving; and a few may-duke cherry, white currant and gooseberry trees, are sometimes trained against these walls with the view of their affording a late crop.

Bricks, it is generally allowed, are the best material of which to construct the walls. The foundation and basement are often made of common building sandstone, while the superstructure is brick; and sometimes the back part of the wall is of sandstone, and the front only of brick. Sandstone which rises in flags is the best substitute for bricks. Both kinds of materials admit of the branches of the trees being nailed-in regularly, and without difficulty. Where the walls are of common rubble building, a trellis of spars is sometimes placed against them, and to this trellis the branches are tied with osier-twigs or rope-yarn. This is regarded as a very good plan; but the expense is considerable, as, to prevent the lodging of insects, the trellis must be smooth and painted. The trees thus enjoy the shelter and reflected heat of the wall, without being injured by its dampness in rainy weather; and as the wall is not injured by the driving and drawing of nails, there are fewer lurking-places for the wood-louse and the snail. The rails of the trellis are made closer or wider according to the nature of the tree to be trained against it. In a few instances in Scotland, walls have been built of different kinds of whinstone, chiefly greenstone and basalt. These minerals, on account of their almost black colour, are calculated to absorb and retain more heat than stones of a light hue: but it is to be considered that it is not the heat retained by the wall which benefits the tree, so much as the heat reflected from the wall. A coping is necessary to preserve the wall, not only by preventing the rain from sinking into it at the top, but to throw it off from the sides, where its trickling down would do much damage. The best coping is formed of long pieces of freestone, neatly hewn from four inches thick in the centre to two at the plinth; the edges being made to project beyond the wall about two or three inches, and a groove being run underneath the plinth, to collect and throw off the drops.

Hot Walls.—It may be proper in this place to say a few words of flued walls, as by much the best time for their construction is at the original enclosing of the garden. Hot walls are of two kinds; such as are intended to have sloping glass-frames attached to them, thus to a certain extent forcing the fruit; and such as are not calculated for having this appendage, but merely to have screens over the blossoms in the spring. Both are generally built about ten or twelve feet high.

In the first kind of hot wall, a ground plate or low parapet, a foot high, and at the distance of perhaps five feet from the wall, is, in some places, formed for the glass frames to rest upon, these being heavy and strong; the trees are trained on a trellis within a few inches of the wall; and along the border in front of the trees, early crops of pease, kidney-beans, or strawberries are raised. In other places, the frames are of very slight construction, and easily manageable; they are about two feet shorter than the height of the wall; and this deficiency is supplied by a boarded parapet, on which rest the rafters for supporting the sashes: the space between the bottom of these and the wall, seldom exceeds three feet. One furnace is sufficient for 45 or 50 feet of such frame-work. When the new wood of the tree is sufficiently ripened, the whole is taken down and carried under cover. When there is a considerable extent of hot wall, adapted for the reception of glass frames, perhaps 250 or 300 feet, particular trees may be forced or omitted, and an opportunity is thus afforded of restoring trees, by allowing them a year's rest. For these hot walls, fire heat is required only for about four months, from the end of February to the end of May, and again for two or three weeks, when the new wood is ripening.

Flued walls, with an apparatus for temporary coverings of canvass, oiled paper, or woollen nets, are necessary for the perfect production of the finer sorts of peaches and nectarines in all parts of Britain north of Yorkshire. Without the aid of artificial heat, the young wood of these trees is seldom sufficiently ripened, in ordinary seasons, to ensure a supply of good flower-buds for the following year, and unless the buds be strong and plump, the chance of a crop the ensuing season is proportionally lessened; and frequently, after a sufficient quantity of fruit has been brought to full size, unless heat be supplied artificially, in autumn, maturation is not effected. In the northern parts of the island, therefore, it is always proper to construct a portion of the garden walls with flues: the additional expense of forming the flues, particularly where the inside facing only is of brick, is but trifling; and little consideration should be attached to the expense of the small quantity of fuel that may be necessary for promoting the setting of the fruit, and for ripening off the young wood in autumn, the time when it is chiefly wanted. The flues are commonly eighteen or twenty inches deep, and nine inches wide, inside measure, and they make as many turns as the height of the wall will permit. Formerly they made only three turns; but it has been found, that the oftener the flues are returned, provided they draw well, the less heat escapes by the chimney, and consequently the more is evolved from the surface of the wall. The sole of the flue to the length of the first turn, is generally a foot above the level of the border. The front wall of the flue is 4½ inches thick, or a brick on bed, without any inside plastering. In some places a wooden trellis covers the wall; but in general, the trellis does not extend higher than the first range of the flue, the heat above this not injuring the trees; where neatness is much studied, the trellis rods are sunk into a small recess purposely left in the wall, thus preventing the appearance of bulging, which is otherwise unavoidable.

Soils.—The improvement of the soil naturally becomes an object of great importance at the first formation of a garden; and its subsequent management, or "keeping in heart," as gardeners term it, is a matter of equal interest. A mixture of clay and sand is called *loam;* and according as the one or other of these earths predominates, the soil is denominated a clayey or a sandy loam. In the same way, in some counties of England chalky loams are common; in other districts, gravelly loams are not unfrequent. When oxide of iron prevails, and renders the clay hard and of a dark brown or red colour, the soil is called ferruginous loam, or more commonly *till.* Boggy or heathy soil consists of ligneous particles, or the decayed roots, stems and leaves of various carices, heaths and sphagnums, and the coaly matter derived from these, generally with a slight mixture of argillaceous earth and sand. See our separate articles on the different varieties of soil.

The soil of a garden should never be less than two feet and a half deep; the best gardeners prefer having it fully three feet. The natural soil, therefore, however good, is seldom of sufficient depth. If it be not two feet, a quantity of earth from the fields is carried in. The cleanings of roads and grass-turf of any kind, form valuable additions to garden soil. In the course of trenching, a portion of the subsoil is brought to the surface, and gradually meliorated; but to bring up much of it at once, is very injurious. Soil of the usual depth may be trenched two spit (spadeful) deep; and if this be done every third year, it is evident that the surface which has produced three crops, will rest for the next three years; thus giving a much better chance of constantly producing healthy and luxuriant crops, and with one-half the manure that would otherwise be requisite. Nicol insists for the deeper soil, and recommends that, after taking three crops, the ground should be trenched three spit, by which the bottom and top are reversed; three crops are again to be taken, and the ground trenched two spit, by which the soil which formed the top goes to the middle, and that which lay in the middle goes to the surface. After other three crops, the trenching is to be again three spit deep. By thus alternately trenching two spit and three, after intervals of three years, the surface soil is regularly changed, resting six years and producing three; and an approach is thus made to the desirable object of having always a new soil.

It is agreed on all hands, that nothing contributes more to the preserving of the soil of a garden in good condition, than exposing it as often as possible to the action of the sun and air. It is a rule, therefore, that garden ground, when not in crop, should regularly be dug rough, or if possible ridged up, and left in that state to the influence of the atmosphere. If it be allowed both a winter and a summer fallow, the oftener a new surface is exposed the better; after it has lain ridged up during winter, therefore, repeated diggings are given in the spring and summer months. Whether some noxious matter be exhaled, or some fertilizing substance be imbibed, or what may be the precise nature of the operation that goes on, we do not here inquire. The fact is certain, that *aeration*, as it is sometimes called, is of the greatest advantage to garden soils. See the article FALLOW.

It has been already remarked, that it is desirable to have soils of different quality in the garden. One of the most generally desired is what is called *mould*, by which is meant a soil in which vegetable earth predominates. Such as is of a bright chestnut colour is preferred: it is usually styled by gardeners, hazelly mould, or hazelly loam, from being of the colour of the hazel nut. The character of the best mould, according to Miller, is, that "it cuts like butter, does not stick obstinately, but is short, tolerably light, breaking into small clods, is sweet, well-tempered, without crusting or chapping in dry weather, or turning to mortar in wet." It should be so open, as not to stick to the spade or the fingers after a shower of rain. Dark grey and russet-coloured moulds are likewise considered good; ash-coloured are commonly bad; yellowish-red still worse. Good moulds after being broke up by the spade, or after rain, if the surface have been recently dug or hoed, emit rather a pleasant smell. What are called brick moulds or loams, are much esteemed both by the gardener and the florist, as auxiliaries to mix with other soils.

For some purposes a sandy soil is wanted. In this case, either the surface sand, from a sandy pasture, is alone used, as it contains a considerable portion of vegetable matter, or if pure sea or river sand be employed, light rich mould, nearly in the proportion of one-half, is mixed along with it. For a very great number of plants, particularly in the flower-garden, an excellent soil is to be found in the turf of old pastures, and the earth which adheres to the turf to the depth of six or eight inches, mixed with a portion of cow and horse dung in a rotten state, laid together in a heap for at least a year, and frequently turned over. This is a *compost*, and naturally leads us to speak more particularly on the subject of manures.

Manures.—To enter fully on an account of manures, or the theory of their action, would here be out of place. Manures and the various theories of their actions are treated of under separate articles in this work; and the remarks here made, shall be confined to manures considered as particularly applicable to gardens.

It is now an established fact in practical gardening, that for the greater number of culinary plants, and for all fruit-trees and flowers, composts or compound manures are far preferable to simple dungs, and that till the latter be completely rotted, they should not in any case be suffered to touch the roots of the plants. Even composts should not be too rich. Trees especially are very apt to be injured by the injudicious and excessive use of manure. A very rich compost will stimulate them for a few years to preternatural exertion; but will in all probability become the source of disease and of early decay. A very good practical gardener recommends for cold clayey land a compost made up in the following proportions: three parts light mould; one part rotten stable dung; one part sharp sand; one part coal-ashes; half a part lime, with a small proportion, perhaps an eighth part, of pigeons' or sheep's dung. For a light sandy soil, the following are the ingredients and proportions: to two parts of the natural soil, three parts of pond earth, or the scourings of ditches, and three of strong loamy earth; one part of clay, or rather clay-marl if it can be got; and two parts of stable or cow-house dung.

In the opinion of some gardeners, the best mode of applying compost manures, is to trench deep, and put compost in the bottom, to the thickness perhaps of eight inches; then to lay on the old garden soil, and to cover the whole with compost to the depth of some inches. In this way, the old or worn out soil is placed in the middle, and is exposed to the effluvia which may arise from the lower stratum, and at the same time is incorporated, by digging, with the upper.

In the neighbourhood of the coast, sea-weed is often used: and if dug in soon after being collected, its fertilizing powers are considerable; for artichokes, asparagus, seacale, and cabbage, indeed, there cannot be a better manure. The careful gardener pays great attention to the preservation of the dung of the stable and the cow-house. The essence of these kinds of dung is often in some measure lost, by the drainings being allowed to escape. These should be collected in cisterns, and poured occasionally over the dunghill or the compost-heap. Indeed it appears evident, that every large garden, and every well-regulated farm, should be furnished with a close shed as a dung store, for dungs, properly so called, should be as little exposed to the influences of the weather as possible. It is two centuries since this was pointed out by Sir Hugh Platt, who recommends the building of a brick receptacle, and covering it over, so as to prevent the access of rain, and exclude air to a certain degree.

Mr. Knight has proved, that vegetable matter in its recent and organized state may be employed as a manure with more advantage than when it has been decomposed. It is evident, that no inconsiderable proportion of its component parts must be dissipated and lost during the progress of the putrefactive fermentation; and it is no less evident, that if this process be made to go on beneath the surface of the soil, the exhaled particles must first be applied to the roots of the plants before they can escape.

Fruit-tree Borders.—The proper forming and managing of borders for fruit-trees is a matter of great consequence, especially when peaches and nectarines, vines, and the best sorts of plums and pears, are cultivated. In many old gardens the borders are only five or six feet broad, and are crowded with perennial flowering plants. Such borders are too narrow, and such plants must greatly rob the trees of their nourishment. The border, according to a gardener's common rule, should not be less in breadth than the wall is in height; but the general breadth is only from 8 to 12 feet. If care be taken to make the soil good below the walk, such a border may prove sufficient. If the bottom be not dry, it is made so by means of drains. Many are of opinion, that it should at the same time be rendered impervious to the roots of the trees, by means of lime-rubbish, or clay and gravel rolled hard, or by complete paving: this precaution is particularly necessary where the subsoil is a cold wet till. Gardeners always wish the soil of their borders to be more than two feet deep; for pear-trees it should be three feet at least. In many cases, no part of the natural soil is retained; but the entire border is formed, partly of good loam brought from the neighbouring fields, or prepared by rotting some old pasture turf, and partly of such compost moulds as have been already described. When the natural soil is to some extent retained, if it be a strong clay, it is opened by adding sea sand, or coal-ashes that have been kept dry. Sometimes in place of these, a small proportion of quicklime is used; but this is seldom advisable. If, on the other hand, the natural soil be loose and sandy, the clayey matter to be found in ditches and open drains in ploughed land is resorted to, and laid about six inches thick at the bottom of the border. Many cultivators are particular in adapting the quality of the soil or compost to the nature of the trees to be planted. For apricot and apple-trees, the compost usually preferred, consists of three-fourths light earth, and one-fourth strong loam, well mixed and incorporated with some thoroughly rotten cow dung. For peach, plum, and pear trees, a stronger soil is prepared, and the proportions are reversed, the loam constituting three-fourths, and the light soil one-fourth. Cherry-trees, too, like rather a cold bottom; and equal parts of light earth and of loam form for them a suitable soil.

The soil of the borders is at first made higher by some inches above the walks, than that of the quarters in the interior of the garden: the reason is, that the quarters annually receive a large accession of manure, whereas the fruit-tree borders are afterwards to receive comparatively little that can add to their depth. Some judicious gardeners contend, that such borders are to be manured only with composts, rendered as homogeneous as possible by frequent turning and intermixing. Others do not hesitate to use well-rotted dung: this is dug in with a three-pronged fork, so as to avoid injuring the roots of the trees; and it is generally applied in the month of November, after the winter dressing of the trees.

Division of the Garden, &c.—It is, of course, understood, that the wall-tree borders extend all around the margin of the garden; it naturally follows that a gravel walk should run parallel with them. On the other side of this walk, in very many gardens, there is a row of espalier-trees (or, to speak more correctly, counter-espalier trees), fixed to trellis-rails. If the enclosure be tolerably extensive, the centre is traversed by a broad walk. If it be of the largest dimensions, and possess a cross wall, or cross walls, the arrangement of the walks falls to be altered accordingly; a main walk proceeding directly to the doors in the centre of the cross walls. The rest of the garden is divided into compartments, and most of these compartments, in some of our best gardens, are laid out in beds four feet wide, with narrow alleys. So many alleys, no doubt, occupy a good deal of room; but the advantages of conveniency and neatness in enabling the workman to clean and gather the crop without trampling the ground, seem to compensate the sacrifice of space. For currant, gooseberry, and raspberry bushes, the quarters are, of course, reserved undivided; and narrow beds are unnecessary in the case of large perennial plants, such as artichokes or rhubarb. Border-edgings are not in use, excepting for the walks next the walls, and the cross walks in very large gardens; for these dwarf box is almost universally employed. In the interior quarters, however, parsley may sometimes be observed forming an edging; and thyme, winter savory, or hyssop, are occasionally employed in the same way, and harmonize very well with the culinary crops around.

Hothouses.—In many gardens, these occupy a very considerable part of the south-wall, that is the wall on the north side of the garden. In the area behind them, are sheds for tanners' bark, rich mould, and other requisites; while there is a cart access to the doors of the furnaces, and these, with all the rubbish necessarily attending the operations of forcing, are completely hid from view. In some places all the forcing-houses form a continuous range; but generally the pine stove and succession pit, being of different dimensions, are placed separately. In some gardens the hothouses have a flower-garden in front of them, while every thing offensive is excluded from view, as in the former case. In other places the hothouses are disposed in a different manner: the several kinds of houses stand detached from one another, each being set down as it were in a separate grass lawn; the back part, where the furnaces are situated, is concealed by shrubs, so that the houses seem to stand in little thickets, and thus form an agreeable variety with clumps and patches of trees in the park. See the articles CONSERVATORY, GREENHOUSE, and HOTHOUSE.

Flower Garden.—In many instances, the flower garden is separated from the fruit and kitchen garden merely by a wall, perhaps by a quick hedge. But in modern *places* (as gardeners speak) this garden is removed from the other by a considerable distance. To it belongs the greenhouse and the orangery; there is often connected with it a conservatory; and sometimes, where the owner has a taste for the culture of rare plants, a stove merely for the keeping of tender exotics.

Slip.—Where the interior of the walled garden does not afford space enough for raising a sufficient supply of culinary vegetables for the family, a piece of ground is fenced off on the outside of the walls, on one or more sides, and is called the *slip*. If the melon and cucumber ground be not situated at the back of the principal suite of hothouses, it may very conveniently be placed in the slip.

Hedges.—For tall hedges, to afford additional shelter to particular quarters, or to screen objects from view, various evergreen plants are employed. Holly answers admirably for height, strength and thickness; but it is of very slow growth, and flourishes only in clayey ground. Yew is also excellent, and much used. Several deciduous trees are likewise employed, such as lime, beech, and horn-beam. English elm is occasionally used; and in wet places alder is justly preferred. In very large gardens a hedge of holly or beech running from north to south, is of incalculable advantage, especially if the garden be in the form of a parallelogram, and much exposed to high winds. Small ornamental divisions in gardens are formed of many different kinds of plants, according to the taste of the owner, and the size of the hedge wished for. Laurel, laurustinus, phillyrea, and evergreen oak, are suited to this purpose; as well as pyracantha, sea-purslane, rosemary, and French tamarisk; the last two, however, will not form hedges unless in our southern counties, where the myrtle can withstand the cold of ordinary winters. But of all shrubs used for such division hedges, evergreen privet seems the best; and it is the plant now most frequently employed for that purpose. Some persons are fond of flowering hedges: they are composed of different kinds of rose-bushes, sweet briars, and honeysuckles; the lately introduced Rosa Indica, making here a conspicuous appearance, being equally covered with flowers early and late in the year. Garden hedges of any kind are now much less frequently planted than they used to be. In our climate the fruit-garden must be surrounded with brick or stone walls: these serve not merely for protecting the trees fixed against them, but supersede the necessity of tall hedges for the purpose of shelter. The flower-garden, however, is still chiefly sheltered by evergreen hedges, with rows of tall deciduous shrubs, or low-growing trees behind. In some places these are situated on the declivity or talus of a bank, forming a highly ornamental screen, analogous to the *brise vent* of the French. From the interior of this garden, however, hedges have been nearly banished, by the change of taste, and dislike of every thing formal.

Implements.—Among the principal tools employed in gardening operations the spade may be first named, as the oldest and most indispensable garden-tool. Besides common sized spades for delving, small spades are required for working in the flower-borders. Forks are necessary for pointing over ground where it is improper to use the spade: they are of different sizes, and some have flat and others rounded tines. Hoes of different sizes are indispensable, with small weeding and thinning hoes, and also the sort called the Dutch hoe. Rakes of different sizes are necessary: for large ones, those in which the teeth are of iron, and the head of well-seasoned ash, are best; and for small ones, those in which the teeth and head are formed of one solid piece of iron, are to be preferred. Shears for clipping hedges, and a kind with bent handles for dressing grass-verges, are not to be forgotten. A flat faced hammer, with large headed nails, both of wrought iron and of cast iron, and a stock of lists or *roonds* are requisite for the nailing of wall-trees: as well as a proper wall-ladder. Pruning, grafting, and budding knives, with hand-bills, chisels, and small saws, are indispensable. Some recently invented pruning instruments might here be noticed. One called the averruncator has a handle from 5 to 8 feet in length; by means of a cord and pulley, a lever connected with a cutting blade is acted upon: so that a person standing on the ground may prune the greater part of ordinary sized trees. The pruning-shears are more easily managed, and are found very useful on many occasions, making the cuts more clean and neat than can be done with any kind of knife. Both instruments take off branches an inch and a half in diameter with great ease. Trowels of different sizes and shapes, with planting irons and dibbles, are all very useful implements. These, with scythes and paring-irons, and similar instruments, are manufactured to a great extent at Sheffield; and from the subdivision of labour there established, they are furnished at rates so cheap as cannot fail in a great measure to command the market: but it is not to be disputed, regarding hoes and rakes in particular, that the blacksmiths of some towns not distinguished as manufacturing places, such as Edinburgh, produce these instruments of better materials, if not of neater workmanship. A garden reel and line is constantly needed. Sieves of iron or of brass wire of different degrees of closeness, are required wherever attention is paid to the raising of exotic seedlings. Fumigating bellows are useful for green-houses, vineries and melon-frames. Where forcing is practised, or where a collection of stove-plants is kept, thermometers are necessary: those graduated to the scale of Fahrenheit are universally in use: what is called the botanical thermometer differs in no respect from another, excepting that some terms, such as 'Ananas,' are inscribed at the proper degrees on the sides of the scale. One thermometer is placed in the open air; and in the centre of each of the hot-houses there is another: by comparing these, the propriety of increasing or diminishing the fire-heat or the quantity of fuel, is regulated. Watering-pots are made by tinsmiths, with pipes of different lengths, and with roses more or less closely perforated: for watering delicate seedlings, pots with brass nozles finely perforated are used, producing an extremely light or minutely divided shower. The garden-engine consists of a force pump or barrel, commonly two inches and a quarter in diameter, to the bottom of which, above the valve, is connected an air-vessel: into this the water is forced; and it is emitted from it, by the action of the compressed air, through the directing pipe in a continued stream. This pipe is attached to the top of the air-vessel by means of a swan-neck swivel joint, with double screws, which are water tight: in this way the pipe can be moved in any direction. Formerly, leathern valves, and a leathern flexible director pipe were in use; but from occasional exposure to drought, the seams of the leather were very apt to open, and allow water to escape; well executed brass work, on the other hand, is of all others least liable to derangement. The pump and air-vessel are fixed in a copper cistern, sixteen inches deep, and capable of containing about twenty-two gallons of water, wine measure. The cistern has likewise a strong wooden bottom, to which are attached two rollers, which greatly facilitate the moving of it when taken into hothouses or vineries. The engine is, at the same time, fitted to a barrow with wheels, for the conveniency of wheeling it through the garden; and to this the rollers form no obstacle, as they pass between the *steels* of the barrow. The pump is worked by a lever, and requires very little exertion. The water can be projected about fifty feet; so that wall-trees of any height may be washed, while the engine remains on the gravel walk.

Private Gardens.—Many of the private gardens in this country are, it is believed, superior in some respects to those of any other. They are maintained in a more liberal style; and the products are not only plentiful, but every kind of fruit and culinary vegetable is of the first quality of its kind. It may be affirmed, that in Britain a gentleman may derive from his own garden, with the aid of glass and of fire-heat, a more varied and richer dessert, throughout the year, than is to be met with on the most luxurious table in any other country. To prove this assertion, it will be enough to run over the fruits successively afforded throughout the year, by a well conducted British garden. Strawberries, planted in pots and forced in a hothouse, produce their fruit about the middle of April, and forced cherries are ready at the same time. These are followed by early melons, about the beginning of May. In June the first forced grapes and peaches are ready for the table, with the luscious pine-apple: may-duke cherries on good exposures now ripen, and different kinds of strawberries in the open ground are abundant. These, with early melons, grapes, peaches, nectarines, and pine-apples, continue plentiful till August, when the currant and gooseberry come in. By the middle of August the early pears are ready, and the later houses of peaches, nectarines, and grapes are in perfection, with melons; and by September, the open wall crops of peaches, apricots, and nectarines, greengage plums, and jargonelle pears, with the late preserved gooseberries and currants, and the early jenneting and oslin apples, swell the dessert. In October, late crops of melons and grapes, with peaches, nectarines, and figs, join themselves with the ripening apples and pears; till, towards the end of it, the careful horticulturist gathers and stores the remaining fruits of his labours, that he may possess a supply during the winter season. The autumn pears, such as the beurré and the crassane, are in season till the new year; when the colmart, St. Germain, and chaumontel, still prolong the succession of pears: then many varieties of keeping apples present themselves, till the season revolve, when *early* strawberries, cherries, and melons may again be procured. Several fruits not generally cultivated, such as oranges and shaddocks, have not here been enumerated; and our nuts, such as filberts and walnuts, are intentionally omitted.

The general extent of the walled garden is from two to five acres. It is to be observed, that a walled garden of three or four acres at the present day, affords as much space for the production of fruits and kitchen vegetables, as did a garden of perhaps five or six acres at the end of the 17th or beginning of the 18th century, when the garden was invariably connected with the mansion-house; so that the portion next the house was naturally laid out as a parterre, and large spaces were occupied by arbours, fountains, and grass-plats for statues or obelisks.

In connexion with the present article, the reader is referred to the article CALENDAR for a manual of the routine of gardening operations throughout the year; to the article HORTICULTURE for some notices of the different processes followed in the art of gardening; to that of LANDSCAPE GARDENING for the principles on which the laying out of pleasure-grounds should be conducted; to the article ORCHARD for the management of fruit trees; and generally to the special articles which our pages contain, on almost every object of interest to the scientific or the practical gardener.

GARDEN BALSAM,—botanically *Justicia Pectoralis.* A medicinal, tropical, evergreen herb, of the acanthus tribe. It usually attains a height of about 3 feet; and it carries a purple flower in May and June. The West Indians use it as a vulnerary. It was introduced about 60 years ago to the botanical collections of British hothouses.

GARDENER. A person who performs the routine work or has the professional management of a garden, or of any piece of garden scenery. Gardeners are as wide in the intervals of their qualifications, wealth, and civil status, as farmers; and considerably more numerous in intermediate gradations. A gardener at one extreme of his profession, may be little more than a spadesman or a jobbing day-labourer upon small spots of land; and a gardener at the other extreme may be a designer of the park-landscapes of the nobility, a professional gentleman of high status, a botanist, a phytologist, a naturalist, a chemist, and a general scholar. Gardeners are distributable, also, into the three classes of apprentices, journeymen, and masters. But a gardener, in the most frequent, and perhaps normal sense of the word, is a person who possesses the qualifications of both art and science requisite for the proper management of all the particular affairs of a park or demesne, comprising those of the lawn, the shrubbery, the kitchen-garden, the flower-garden, the forcing-beds, the conservatory, and the green-house. One grand attraction of this character is, that, while honourable, delightful, and eminently favourable to the higher order of intellectual, moral, and religious enjoyments, it may be attained before middle-life, or even in comparatively early life, by any gardener-apprentice who practises steadiness of aim, and makes a fair use of his opportunities. Though the cares and labours of gardening, throughout the whole of apprenticeship and journeymanship, are many and arduous; yet they abound in sources of intellectual pleasure, they possess remarkable freedom from monotony or tiresomeness, they involve a continual play of novelty, and elicit constant incitements to prosecute knowledge, and they are always accompanied with valuable facilities for making both useful and gratifying acquirements.

A young gardener, who employs most of his leisure hours in reading, from the beginning of his apprenticeship till he is 21 or 22 years of age, may possess a very respectable acquaintance with geography, history, art, science, and general literature; and he ought, in the constant daily course of his labours in the garden, as well as in some degree in his hours of leisure, to make continual observations and inquiries, not only in the mere arts and manipulations of horticulture, but in systematic botany, in vegetable physiology, in meteorology, in natural history, and in organic chemistry. "An apprentice," too, says Loudon, "besides studying his art in the garden of his master, should, as often as may be, visit those of his neighbours, and observe what is going on there. His apprenticeship completed, he should move to a different part of the country, performing the journey leisurely on foot, botanizing and collecting insects and minerals, and visiting every distinguished garden on his way. When he settles, it should be in a different kind of garden to that in which he was before, and there he should continue a year, and then remove and travel to another part of the country, and settle there a year, and so on, till he attains his twenty-fifth year, when he may undertake the situation of master. During the whole period in which he is journeyman, he should be steadily and unceasingly employed in improving himself, first in his own art and the branches of knowledge, as botany, natural history, chemistry, weather, &c.,

on which it more immediately depends; and next, if his ambition permits, on general subjects of literature, arts, and sciences."

GARDENERS' GARTERS. See Arundo.

GARDENIA. A genus of ornamental, tropical, evergreen shrubs, of the madder tribe. About 30 species have been introduced to Britain, since the middle of last century, partly from Africa and America, but chiefly from India and China; and upwards of twenty more are known to botanists. Some of the most esteemed of the introduced species, are *G. radicans*, introduced about 22 years ago from China, 12 or 15 inches high, and carrying white flowers from March till June; *G. florida*, introduced 90 years ago from China, 5 or 6 feet high, and carrying pale yellow flowers from July till October; *G. latifolia*, introduced about 60 years ago from India, 7 or 8 feet high, and also carrying pale yellow flowers; *G. campanulata*, introduced about 30 years ago from India; *G. lucida*, introduced about 48 years ago from India, 4 or 4½ feet high, and carrying white flowers; *G. uliginosa*, introduced about 45 years ago from India, 3 feet high, and carrying white flowers from July till September; *G. micrantha*, introduced about 40 years ago from China, 4 or 4½ feet high, and carrying white flowers; *G. pavetta*, introduced about 30 years ago from India, 6 or 7 feet high, and carrying white flowers in July and August; and *G. dumetorum*, called by some botanists *Posoqueria dumetorum*, and by others *Canthium coronatum*, introduced about 70 years ago from India, 6 or 7 feet high, carrying white flowers from July till September, and held in esteem in its native country on account of the medicinal properties of its roots.

But one of the most magnificent, as well as recently introduced, specimens of the whole genus is Lord Derby's species, *G. Stanleyana*. This was brought two or three years ago from Sierra Leone, and has already proved itself a most gorgeous addition to the ornaments of the British hothouse. Its stem is erect, its branches spread out horizontally, or with a slightly drooping habit, from the upper part of the stem; its leaves are opposite, oval, and shining; and its trumpet-shaped flowers rise up, in great profusion, from the axils of the leaves, like a series of large and very fragrant spotted japan lilies. Each flower is about 9 inches long and 6 inches wide; its tube has a fine deep purple colour; the five broadly-ovate segments of the limb of the corolla are purple and white without, pure white within, tinted with a shade of blush near the mouth, and covered, except at the margin, with oblong dots of deep purple elegantly arranged in oblique lines; and when the corolla begins to pass from health towards decay, the purity of the white margin gives place to a delicate flesh colour. This superb plant is easily cultivated in the stove, comes at a very early period of its existence into flower, and is a remarkably free bloomer; and it seems to succeed best, or at all events is eminently successful, in a mixture of nearly equal parts of silver sand, leaf-mould, and rough peat earth.

GARDENING. See Horticulture.

GARDEN ROCAMBOLE. See Rocambole.

GARDEN WARBLER, or Greater Pettichaps, —scientifically *Curruca Hortensis*. A British song-bird, of the sylviadæ order. It is a congener of the white-throat, and belongs to the same family as the blackcap and the nightingale. It abounds throughout the south of Europe; and sojourns in England and Scotland, particularly in districts which are rich in wood and water, from April till September. It closely approaches the blackcap and the nightingale in the variety and mellifluousness of its music, and sometimes prolongs its warbling till after sunset; but it is shy and secluded, and hides itself among the densest foliage of the grove, and can very seldom be seen. It appears to be the true beccafico or fig-eater of the Italians; though it shares that name with fat and plump individuals of several other species of sylviadæ. Its total length is scarcely six inches; its upper surface is an uniform hair-coloured brown; and its under surface is a dull brownish white. Its nest is built on low bushes or among luxuriant herbage, and consists, for the most part, of bents, goose-grass, and a little wool and hair; and its eggs of one season amount to four or five, and have a greenish-white ground colour, and ash-green and light brown spots and streaks. The garden warbler regales the gardener with its song, but exacts from him in return a few cherries, berries, and other fruits.

GARDOQUIA. A genus of tender, ornamental plants, of the labiate-flowered family. The many-flowered species, *G. multiflora*, was introduced to Britain a few years ago from Chili; and is a very beautiful evergreen undershrub, of 12 or 15 inches in height, carrying scarlet flowers from June till September.—The betony-like species, *G. betonicoides*, is a fragrant evergreen herb, with bright purple flowers, and was recently introduced from Mexico.—The two-coloured species, and Gillies' species, the former with purple flowers and from the Caraccas, and the latter with lilac flowers and from Chili, and both small evergreen shrubs, were introduced to Britain before 1830.

GARGET. An inflammatory disease in the udder of cows and ewes, and occasionally in hogs and yearling heifers.

The causes of garget in the cow are principally improper treatment after calving, exposure to cold and wet, neglect of bleeding or physicking in the advanced stages of parturition, the leaving of portions or dregs of the milk undrawn at the time of milking, a habit of lying in such a posture as to crush the udder, and the allowing of the animal to acquire an unduly plump and fat condition, especially at a time of hot and sultry weather. The causes in the ewe are similar; though the chief are wet lair, hard pasture, the removal of one of twin lambs from suckling, and various kinds of constitutional derangement.

The principal cause in yearling heifers is cold air and wet lair.

An udder affected with garget may suffer in either one or more quarters; it swells, hardens, becomes knotty, has more heat than in a state of health, and appears to be much pained when pressed. The secretion of milk either lessens and becomes mingled with blood and pus, or is entirely arrested and gives place to suppuration, and in very bad cases to gangrene. The hinder extremities, particularly about the fetlock, the hock, and the hip-joint, in many instances, sympathize with the udder, and undergo so much swelling and inflammation as to prevent the animal from rising except with very great difficulty, or even from rising at all, or almost from moving. The symptoms in the ewe are similar; but, in the worst cases, they are both very sudden and exceedingly violent, and may raise such a gangrene as will prove fatal to the animal within 24 hours of the commencement of the attack. The symptoms in the yearling heifer are chronic and comparatively gentle, and have been supposed to resemble those of rheumatism in the human subject, and are removeable by means of the simple and natural remedy of dry pasture and comfortable litter.

A cow attacked with garget must be kept in the house and have soft dry litter; she ought to be fed for a day or two on mashes with a little hay; and when she becomes well enough to leave the house, she ought to be turned on quite dry and rather short pasture. If the attack be slight, she should have her udder tossed, tumbled, and sucked at the unrestrained will of the calf; if it have a decidedly inflammatory character, and be accompanied with fever and loss of appetite, she should be bled with all speed, and receive a dose of physic, and have her udder abundantly fomented, and be thoroughly milked twice a-day, and have a quantity of camphorated mercurial ointment rubbed well into the udder after each milking, and washed off again with warm water immediately before the next milking; if the indurations prove obstinate, an iodine ointment, composed of lard and hydriodate of potash, must be substituted for the camphorated mercurial ointment; and if gangrene set in, and develop a putrifying ulcer, the sore must be well cleaned with warm water and freely washed with a weak dilution of chloride of lime, from time to time, till the gangrenous matter be considerably reduced, and then alternately dressed with Friar's balsam, and washed with the dilution of chloride of lime till the gangrenous matter wholly disappear; and if indurations and chronic enlargements, accompanied by deficiency in the lactic secretion, continue after all inflammatory action has been subdued, the hydriodate of potash must continue to be applied in the form of ointment, and, if need be, internally administered in some other form.—The proper treatment of a gargeted ewe is in all respects similar to that of a gargeted cow. A gargeted hog should be bled, and should receive warm cordial stimulating drinks.

GARGYSE. See Blain.

GARIDELLA. A small genus of plants, of the ranunculus tribe. The nigella-leaved species, *G. nigellastrum*, is a hardy, ornamental annual, of about 15 inches in height; and was long ago introduced to Britain from France.

GARLAND-FLOWER. Three ornamental shrubs, of respectively the wild-olive, the dillenia, and the heath families. The wild-olive garland-flower, *Daphne cneorum*, is called also the spear-leaved daphne and the cluster-flowering daphne. It is a hardy, evergreen undershrub, of 12 or 15 inches in height; and was introduced to Britain, nearly a century ago, from Austria. Its stem is branching and shrubby; its leaves grow irregularly on the branches, and are spear-shaped and narrow; and its flowers are produced in clusters at the ends of the twigs, and appear from April till September, and have a purplish pink colour and nearly as grateful a fragrance as the mezereon.—The dillenia garland-flower, *Pleurandra cneorum*, is a yellow-flowered, Australian, evergreen shrub, of about 2 feet in height, and was introduced to Britain about 22 years ago.—The heath garland-flower, *Erica persoluta*, is a globose-flowered, Cape of Good Hope heath, of about 20 inches in height, and comprises three varieties, with respectively white, pink, and red flowers, all of which have been introduced to British conservatories.

GARLIC. A species of onion, *Allium Sativum*, cultivated in Europe since the year 1551. The leaves are grass-like, and differ from those of the common onion in not being fistulous. The stem is about two feet high, terminated by a head composed principally of bulbs instead of flowers; the flowers are white, and furnished with tricuspidate stamens; the root is a compound bulb, consisting of several smaller bulbs, commonly denominated *cloves*, enveloped by a common membrane. Garlic has a strong, penetrating odour, and pungent acrid taste. It differs from the onion only by being more powerful in its effects. In warm climates, where garlic is produced with considerable less acrimony than in cold ones, it is much used, both as a seasoning and as a food. When bruised and applied to the skin, it causes inflammation and raises blisters. In the south of Europe, particularly in Spain, it is very much used, entering into the composition of almost every dish, not only among the common people, but among the higher classes of society; and it is every where prized by epicures. At all times, however, it has experienced much contrariety of opinion, and has been adored by some nations, and detested by others, as by the ancient Greeks. Its cultivation is easy, being a hardy plant, growing in almost every kind of soil; and it is reproduced by planting the radical or floral bulbs. Its medicinal virtues have also been much celebrated. It not only forms an excellent expectorant, but has been administered in a great variety of diseases, as hysteria, dropsy, cutaneous eruptions, obstructions, &c. The juice of garlic is a strong cement for broken glass and china. Snails, worms and the grubs or larvæ of insects, as well as moles and other vermin, may all be driven away by placing preparations of garlic in or near their haunts. The virtues of garlic are most perfectly and readily extracted by spirit of wine.

GARNER. A repository for corn, small or large, binn or granary.

GARRYA. A genus of beautiful, evergreen, diœcious shrubs, nearly allied to the coniferous order, but constituting the type of a separate order called Garryaceæ. The elliptic-leaved species, *G. elliptica*, was introduced to Britain from New California in 1828, and flowered in the garden of the Horticultural Society in 1833; and the ovate-leaved species, *G. ovata*, was afterwards introduced, and brought to flower. The two species are intimately allied to each other; and both flower in winter, and hang out a profusion of catkins, which closely resemble the most elegant and elaborate artificial tassels; and they grow in the open ground, and require little or no protection.

GARTH. A yard, a croft, or any small piece of ground behind house or offices.

GAS. The name of every permanently elastic aëriform substance. Gas is distinguished from steam, or vapour, by this circumstance, that vapours are raised from all fluids by heat, and are again condensable by cold into the same fluid form: but gases are obtained from the substances containing them only by chemical decomposition, whether this be spontaneous or artificial. All air was considered as a uniform, homogeneous substance, till about the middle of the last century, when it was discovered that there existed at least as great differences among aëriform as among fluid substances. Accustomed, however, to regard the atmosphere as the only air, philosophers called these new forms of air *gases*, to distinguish them from it. This name had been already introduced to the sciences by Van Helmont, and was derived from the old German word *giesch*.

Every gas consists of some ponderable base, or substance, which is maintained in its aëriform state by means of heat or caloric; thus, all gases possess common properties of elasticity, &c., which they derive from the last substance; and also each one its distinguishing or peculiar characters, derived from the substance constituting its base. Each kind of gas has also its own peculiar and uniform specific gravity, or weight, although they are all several hundred times lighter than water. The density of all gases is, like that of air, proportioned to the pressure to which they are subjected; and, like air, they expand with the application of heat, and are rendered more dense by its abstraction. All gases are susceptible of forming various combinations with fluid and solid substances, and these become fixed in a solid or fluid form.

Elasticity.—Gases are perfectly elastic bodies. The elasticity of solids is within certain limits only. The best springs of locomotive engines and carriages seem capable of suffering but a limited number of bendings before they break. Air remains constantly elastic; it has been shut up for years in the air-vessel of a hydraulic engine, and still exhibited this property as perfectly as at first. Boyle, and afterwards Mariotte, investigated the law of the elasticity of gases, and demonstrated that the volume is inversely as the pressure. As we remove the pressure, they constantly expand, and always fill completely the vessel in which they are contained.

Weight of Gases.—It has been demonstrated that a flask from which the air has been exhausted weighs less than when full. The weighing of gases is a nice operation, requiring great care that the gas be pure, dry, and under a known pressure and temperature. Philosophers have assumed as a standard-pressure 30 inches of the barometer, and a temperature of 60° F. In the following table we have the weight of 100 cubic inches of several vapours and gases, with their specific gravity or density, air being considered as 1.

Specific Gravity of Gases and Vapours.

	Weight in Grains.	Specific Gravity. Air 1.	Weight of 1 Cubic Ft. in Grs.
Atmospheric air, ...	31·0117	1·	535·68
Oxygen, ...	34·109	1·1025	590·2
Nitrogen, ...	30·166	0·9722	521·8
Hydrogen, ...	2·137	0·0690	36·29
Vapour of water at 60°. .	0·356	0·0115	6·04
Vapour of water at 212°, .	19·22	0·6240	331·7
Carbonic acid, ...	47·262	1·5239	815·6
Carbonic oxide, ...	30·207	0·9727	521·8
Vapour of alcohol, . . .	49·618	1·6012	857·
Vapour of sulphuric ether, .	80·010	2·5822	1382·4
Carburetted hydrogen, .	17·45	0·558	298·5

The pressure which gases exert upon bodies at the surface of the earth depends upon their weight, and as hydrogen is but one-sixteenth the weight of common air, an atmosphere of the same height will press with a force of one-sixteenth only. Hence, a man would weigh more, and require a greater force to transmit himself from place to place, in an atmosphere of hydrogen, than in the present atmosphere. The velocity with which air enters a vacuum depends upon the height of the column of air above it, and consequently varies with its density. It is obvious, that, as the density depends upon the height of the incumbent column, it must be constantly diminishing as we ascend, until we arrive at a point at which there will be but a single layer of particles, and the two forces of weight, or attraction of gravitation, and elasticity of the air, be in exact equilibrium. Hence, the height of any point may be ascertained by weighing the superincumbent column of air against a column of mercury,—the higher the point, the shorter will be the column of mercury. It is thus that heights are measured by the barometer.

Diffusion of Gases.—Aëriform bodies possess the property of diffusing themselves through each other's masses to an unlimited extent; there is no point at which they become saturated. Mr. Dalton filled two cylindrical vessels, the one with carbonic acid, and the other with hydrogen; the latter was placed perpendicularly over the former, and the two connected together by means of a small tube two or three feet long. In the course of a few hours, hydrogen was detected in the lower vessel, and carbonic acid in the upper; after a still longer time, these gases were found perfectly and equally mixed. If we examine the table of the specific gravity of gases, above given, we shall find that carbonic acid is more than twenty times the weight of hydrogen; consequently the change of place was produced in opposition to the laws of gravity. This property belongs to all gases and vapours. If water be placed in a vessel of dry air, evaporation will go on as in a vacuum, but more slowly, the air acting as a mechanical obstacle; and the tension or elastic force of the vapour will be precisely the same in the one case as in the other. A given volume of air will contain the same weight of vapour as a vacuum of the same dimensions. Mr. Dalton, in his explanation of these phenomena, supposes that the atoms of one gas, although highly repulsive to each other, do not repel those of other gases; that, in the case of carbonic acid and hydrogen, each allows the atoms of the other to insinuate themselves between its own atoms, and establish a perfectly equal mixture. "One gas," he says, "acts as a vacuum with respect to the other." By this expression, however, he did not mean that one gas flowed into another with the same velocity as into a vacuum,—for the atoms offer a mechanical impediment to diffusion,—but that, although more slowly, the final result would be the same. This has an important bearing upon the perfect mixture of gases in combustion. When a portion of gas is confined in a glass vessel having a crack in its side, the gas after a time will have diffused itself into the air, and the air will have found its way through the same opening into the gas. The quantities which have thus passed in a given time will bear a certain relation to the specific gravities of the two gases. The diffusion depends in no degree on the size of the aperture, but each gas has a diffusiveness peculiar to itself. Professor Graham was enabled to determine the law of diffusion with great exactness by means of a tube closed at one end with plaster of Paris. By filling this tube, over water, with the gas to be experimented upon, and allowing it to remain with its lower or open end immersed in the water, the diffusion immediately commenced through the porous stopper, and the water was seen rising in the tube. From experiments carefully conducted with this instrument,—or *diffusion tube*, as it is called,—Professor Graham discovered that "the diffusion or spontaneous intermixture of two gases in contact is effected by interchange in position of indefinitely small volumes of the gases, which volumes are not necessarily of equal magnitude, being, in the case of each gas, inversely proportional to the square root of the density of that gas." Thus, the density of the air being 1, its diffusiveness will be 1 also; and knowing the density of other gases compared with it, we may deduce their rate of diffusion.

The following figures indicate the densities of some of the gases, with their diffusiveness, according to this law:—

Hydrogen	$\sqrt{0.069} = 0.2627$
Oxygen	$\sqrt{1.105} = 1.052$
Nitrogen	$\sqrt{0.972} = 0.986$
Steam	$\sqrt{0.620} = 0.788$

0.2627 : 1 : : 1 : 3.807 = Diffusiveness of hydrogen.
1.052 : 1 : : 1 : 0.9505 = " oxygen.
0.986 : 1 : : 1 : 1.014 = " nitrogen.
0.788 : 1 : : 1 : 1.269 = " steam.

The results of these experiments coincide so exactly with the law, that the density of the gas may be determined by experimentally determining its diffusion. As a further confirmation of Dalton's theory, it may be remarked, that all gases rush into a vacuum with a velocity also inversely proportional to the square roots of their densities. It has been determined, that, if our atmosphere be considered as of the same density throughout, homogeneous, and 27,335 feet in height, the velocity with which it enters a vacuum will be 1,338 feet in a second of time; the velocity of diffusion is, as we have remarked, much less. That this interchange and mixture are the result of affinity or chemical action is disproved by the fact, that it takes place between gases which have no such affinity. Carbonic acid cannot be made to unite with either hydrogen, oxygen, or nitrogen: besides which, it is to be observed, that, when two volumes of different gases are brought in contact, each diffuses itself through the other, occupying the space of the sum of the two, and that without any increase of temperature. When oxygen and nitrogen gases are mixed together in the proportion of 1 to 4, the mixture occupies exactly the space of five volumes of either, and is, according to all the tests which chemistry can apply, pure atmospheric air.

We have explained this law the more fully, that a knowledge of it may prevent mistakes which are serious, in forming a plan for efficient ventilation. We are told, in a work on Warming and Ventilating, "that the ammonia and aqueous vapour invariably ascend towards the ceiling; while the dense carbonic acid will find its way out at the doors and lower apertures, or will remain stagnant in the passages, unless subject to a current of atmospheric air." In a Report on Schoolhouses it is said, "The poisonous parts are called carbonic acid. They are heavier than the common air, and, as the lungs throw them out at the lips, their tendency is to fall towards the ground, and, if there were no currents of the air, would do so. Were these different portions of the air, as they come from the lungs, of different colours, we should, in a perfectly still atmosphere, see the stream divided, part of it falling, and part ascending. A circulation of air, however, produced out of doors by differences of temperature, and in our apartments by the motion of the occupants, and by other causes, keeps the poisonous parts of the air, to some extent, mingled with the rest of it." Farther on we are told, "If there be but little motion in a room, the poisonous part of the air will settle towards the floor as soon as it is cast from the lungs, while the other part, being raised almost to a blood heat in the lungs, will rise to the ceiling. In the ceiling, therefore, should be an aperture for its escape. The carbonic acid will tend to flow out under the door, or when it is opened." In the Report of the Design for a Lunatic asylum, the author remarks, if the register for admitting hot air is high enough to avoid certain difficulties he has mentioned, "the hot air will not be well disseminated, the hottest portion will constitute a stratum next the ceiling, while that at the floor is sour and carbonic." Now, if the law, as stated by Dr. Dalton, "that one gas acts as a vacuum with respect to another," be true, neither statement can be correct; if they were correct, we should certainly provide a means of escape separately for the gases, according to their density. Ample provision is made for diffusion; the expired gases, with the aqueous vapour, are lighter than the surrounding air; they rise to the ceiling, and, if they do not escape, become so completely mixed with it, that they never again separate. It is true that carbonic acid generated in large quantities from low places, where it is retained as in a basin,—in mines, in certain grottos, in wells, and after it becomes cold when generated in close rooms by the combustion of charcoal,—accumulates on the floor; but the conditions are so unlike the cases above mentioned, that no analogy can be maintained, and we are aware of no experiments which would support them.

We can hardly estimate the importance of this beautiful law. Animals and vegetables, as we have already shown, are constantly pouring out certain gases, each essential to the life and growth of the other, and yet, if these gases were allowed to stagnate where they are formed, they would not only injure, but destroy, both kingdoms. By this law, these poisons are diffused throughout space, and vital air rushes in to supply their place; it is only by the most delicate analysis, and for a short time, that any differences in the constitution of the atmosphere can be detected. At the level of the sea, and at the highest point to which man has ascended, it is invariably the same. Yet it is a mixture, and requires no power to decompose it; every substance having an affinity for oxygen removes it as readily as though the nitrogen were altogether absent. Even water effects a separation of its elements, for the air expelled from it by boiling contains more than 21 per cent. of oxygen.

Expansion of Gases.—Unlike solids, gases expand equally for an equal increase of temperature as measured by a thermometer. Gay-Lussac showed that 100 measures of atmospheric air, heated from the freezing to the boiling point, became 137.5 measures; consequently the increase for 180° F. is $\frac{37.5}{100}$ of its bulk; dividing this quantity by 180, we find that a given quantity of dry air expands $\frac{1}{480}$ *of the volume it occupied at* 32° for every degree of Fahrenheit. New experiments have been made by Rudberg, within a few years, giving $\frac{1}{491}$ as the rate of expansion for 1° F.; and these results are confirmed by Regnault. This last number may be adopted as the true increment; its equivalent in decimals is 0.002036; for 1° Centrigrade, it is 0.00365. If we wish to ascertain the volume which 100 cubic inches of a gas at 40° would occupy at 80°, we must remember that it does not expand $\frac{1}{491}$ of its bulk at 40° for each degree, but $\frac{1}{491}$ of its bulk of 32°. Now 491 parts of air at 32° become 492 at 33°, 93 at 34°, and so on; hence we can institute a proportion between the volume at 40° and that at 80°.

Vol. at 40.	Vol. at 80.	Cub. Inch.	Cub. Inch.
491 + 8 :	491 + 48 : :	100 :	108

Absorption of Gases.—Gases are absorbed by different substances, and in some cases the force with which they are drawn to them is greater than the mutual repulsion of the gaseous particles themselves. When a piece of metallic platinum is made perfectly clean and bright, and brought in contact with oxygen and hydrogen, the adhesion of these gases to the metal is apparently such as to overcome their ordinarily repulsive properties, to bring them within the sphere of chemical action, and produce rapid combustion with the evolution of light and heat. Gases are also dissolved in water, as is the case with atmospheric air; it is to this property that the inhabitants of the ocean owe the oxygen which supports their existence. The quantity thus held in solution is in proportion to the pressure. Carbonic acid is dissolved in an equal bulk of water under the ordinary pressure of the atmosphere; by doubling the pressure another volume may be taken up, and so on. It is in this way that the soda water of the shops is kept ready for use under mechanical pressure. On the tops of high mountains, the pressure on the surface of the water is obviously less, and less atmospheric air will be dissolved; it may be owing to this cause that fish are not found to inhabit the ponds of very elevated regions. Charcoal possesses the property of absorbing some gases to a great extent, as may be seen by the following table, in which the numbers indicate the volumes of gases absorbed, that of the charcoal being taken as unity.

Absorption of Gases by Charcoal.

Ammonia . .	90	Bicarb. hydrogen .	35.
Muriatic acid . .	85	Carbonic oxide . .	9.4
Sulphureous acid .	65	Oxygen . .	9.2
Sulphuretted hydrogen .	55	Nitrogen . .	7.5
Nitrous oxide . .	40	Carbur. hydrogen .	5.
Carbonic acid . .	35	Hydrogen . .	1.7

GAS-LIGHTING. The application of the different forms of hydrogen gas to the lighting of streets and buildings. It was some time since pointed out by chemists, that there was a great waste of hydrogen gas in almost all cases of combustion, which might, with profit, be accumulated and made use of. The first ideas upon the subject were thrown out by Lampadius, in the first volume of his Art of Mining, Gottingen, 1801. He was followed by Lebon, in France, the inventor of the thermolampe. The gas for the supply of this lamp was procured from the combustion of wood; but, as a great quantity of wood was required to keep the lamp burning, this experiment of Lebon led to no important results. In 1810 and 1811, the English began to apply the gas obtained from the burning of coal to this purpose, and brought the lighting of streets and manufactories, by means of this gas, to perfection. The great superiority of the English process over that of Lampadius and Lebon, consisted in this, that the gas was accumulated in large vessels before it was burnt, and thus could be preserved in the gasometers till it was needed, while they were obliged to consume theirs as fast as it was produced. And this mode of lighting was, moreover, profitable only where bituminous coal could be obtained at a moderate price. In 1815, many streets and buildings in all parts of London, and other English towns and cities, were lighted in this manner. The mode of making the gas is as follows: large, tight iron vessels, three quarters filled with coal, are heated in furnaces to a red heat; to the end or open mouth of the vessels containing the coal are tightly fitted iron tubes, which convey the substances (gas, water, ammonia, tar) produced by the combustion of the coal to reservoirs, in which they become separated, the tar and water being condensed, while the gas passes on to other vessels, in which the preparation is completed. It is passed through pure water, and through lime-water, by which it is washed and cleansed of its impurities, into the gasometer, in which it remains till wanted for use. This instrument consists of two parts, a large wooden or iron cistern, open above, partly filled with water, and a large open vessel of iron, or some other substance, which is inverted in the water contained in the other, and is suspended and balanced by weights playing over pulleys. Then, as the gas is allowed to enter at the bottom of the cistern, it rises up into, and thus pushes up, the inverted vessel, or gasholder, till it is filled. From this it is let out through tubes provided with stop-cocks. As soon as the cocks are opened, the weight of the gasholder, tending to sink it in the water, forces out the gas it contains. It is then transmitted through small iron or leaden tubes to any part where it is needed. These tubes are laid under the ground, like aqueduct logs, and are thus protected from injury, while the small branches from them, for street or house lamps, are passed through hollow posts, or openings in the walls of the buildings in which they are to be used. The light furnished by them is, beyond doubt, the purest and brightest, as well as least offensive, of any, if we except the

Argand lamps alone. Its advantages are particularly felt in places where many lights are wanted in a small space and for street lights. See the article Coal-Gas.

The following useful remarks on the use of gas are from the columns of that excellent journal 'The Daily News:'—"During the last few years the use of coal gas as a source of artificial light in dwelling-houses, has increased to a very considerable extent; so that it is now no uncommon thing to find drawing-rooms and bed-rooms, as well as halls and staircases, thus lighted; a thing which a few years since was hardly to be met with in London, though it has been common for many years in Edinburgh, Glasgow, and several of the northern towns. The convenience and advantages of gas for lighting houses are very great; if well managed it is cheaper and more cleanly than any other sort of artificial light, whilst, at the same time, there is considerably less danger of accidents from fire than where oil lamps or candles are used. There are, however, several serious objections to gas; and it may therefore be interesting to consider the nature of these objections, in order to ascertain in how far they may be removed, or whether they are essential accompaniments to its use.

"The principal advantages of gas for domestic illumination are, its cheapness, safety, cleanliness, and the little care and attention which it requires when properly arranged and managed. By the use of gas all danger from sparks is avoided, the injury of furniture by dropping oil, wax, or tallow, through carelessness, is prevented, and the lamps when once lighted, if properly regulated, will burn for any number of hours with a bright and equable light, without requiring adjusting or trimming of any kind, as is the case with oil. Of course these advantages are only experienced when the pipes and burners are well arranged and placed under the care of a steady and attentive servant; with a careless person, accidents may possibly be caused from leakage of gas, though, as even a very small escape of gas very soon becomes apparent from its unpleasant odour, very moderate attention would entirely prevent the possibility of accidents of this kind occurring. Even when well managed, however, there are inconveniences not unfrequently found by those who use gas. The ceilings become black and the light is painfully bright and dazzling, the rooms become too hot, and lastly the air becomes oppressive, giving rise to headache, &c.

"The blackening effect produced on the ceilings, is, of course, occasioned by smoke from the imperfect combustion of the gas; different burners give off very various proportions of smoke; Argand burners far more than the flat bats-wing or fish-tail burners, because in the latter the combustion is more perfect. A good gas-burner does not blacken ceilings any more than the best oil lamps or wax candles. Where ceilings are blackened by gas, either the burners are faulty and the gas is not perfectly burnt, or they are turned up too high, so as to form a smoky flame. It is a common and idle custom to turn the gas-cock entirely before lighting the burner; a flaring smoking light is thus obtained, which is then gradually lowered to the proper size; a small but certain quantity of black smoke is circulated through the air of the room every time this is done.

"In consequence of the cheapness of gas, and the facility with which we may regulate the supply of light, people commonly burn more lights than they would, did they use oil or candles, hence the reddish yellow colour of the light becomes trying and painful to the eyes. This may to a great extent be remedied by the use of glasses or shades, slightly tinged blue or bluish green; the light is thus softened, and brought nearer in its character to daylight. In the same way that the use of gas leads people to burn a larger quantity than they would do of oil or wax, it also causes them to forget the large quantity of hot air passing off from every burner, a consideration of great importance, but one which is entirely under our own control: inasmuch as it is easy in all cases to adopt some suitable and efficient mode of ventilation, whereby the temperature of our rooms may be prevented from rising too high.

"The last inconvenience, and in some respects the most serious, is the slow and gradual, but very perceptible effect, which gas sometimes produces on the air of rooms, due to the formation of acid fumes; the source of this requires a few words of explanation. Gas, in burning, produces a quantity of carbonic acid gas, like all ordinary combustibles, and the quantity of this is nearly in proportion to the light the gas gives out in burning. Consequently, the more gas we burn, and the more light we have, the more carbonic acid gas we shall have pouring into our rooms, whether we burn oil, wax, tallow, or gas. This same carbonic acid gas is produced by the process of respiration, and any considerable quantity of it in the air is decidedly unwholesome, though not poisonous, unless the quantity of it be excessive. Coal gas, however, in burning, sometimes produces a considerable quantity of sulphurous acid gas, a substance which, even in small quantity, is irritating and deleterious when taken into the lungs, although mixed with a large bulk of atmospheric air. The coal from which gas is made, commonly contains a considerable quantity of sulphur, and consequently coal gas when freshly made contains various compounds of sulphur. Fortunately, however, gas may be nearly quite purified from sulphur by the use of lime, and accordingly the gas as fast as it is made is passed through purifiers, in which it is exposed to the action of lime; after a time the lime becomes saturated with sulphur, and it must then be changed; if this is not attended to the coal gas passes through the purifier still contaminated with sulphur, and this occasionally is the case. The irritating vapours of sulphurous acid gas, sometimes perceived in rooms where gas is burnt, is caused by want of due care in purifying the gas. The three first objections to the use of gas are entirely under the control of the consumer, the last when it occurs is the fault of the gas manufacturers and should not be suffered to pass unnoticed; it is a serious evil, and at the same time one which he can remedy, and which, for his own sake, as well as that of the consumer, he ought to avoid. It is almost impossible wholly to purify coal-gas, but it is easy to separate from it the greater part of the sulphur which it originally contains. Complaints, and well founded ones, too, have lately been made in various parts of the town, of sulphur in gas, and these, if not attended to in the right quarters, will soon put a stop to the further use of gas for lighting houses; for the various advantages of gas will hardly compensate for the destruction of furniture, and injury to health occasioned by the presence of any quantity of sulphurous acid gas in the air."

GASTERIA. A genus of very curious and grotesque Cape-of-Good-Hope plants, of the day-lily order. Upwards of forty species, varying in height or length from a foot to about a yard, have been introduced to our greenhouses and hothouses; and four of these are shrubby, the rest are herbaceous, and all are evergreen. The flowers of all display some shade of crimson, scarlet, or orange, and have so curious a base as to look like a belly, and suggest the name gasteria,—which is formed from the Greek word for belly; and their leaves are so thick and fleshy, and have so peculiar a shape and surface, as to have suggested for the genus the popular name of tongue-plants. The whole genus possesses similar grotesqueness to the genera haworthia, apicra, and aloe.

GASTRIC JUICE. A fluid of the utmost importance in the process of digestion. It does not act indiscriminately on all substances; nor is it the same in all animals; nor does it continue always of the same nature, even in the same animal, changing according to circumstances. It acts with a chemical energy in dissolving food; attacking the surface of bodies, and uniting to the particles of them. It operates with more energy and rapidity the more the food is divided; and its action is increased by a warm temperature. The food is not merely reduced to very minute parts; its taste and smell are quite changed; its sensible properties are destroyed; and it acquires new and very different ones. This fluid does not act as a ferment; it is a powerful antiseptic, and even restores flesh already putrefied.

GASTRIDIUM. A small genus of grasses, of the agrostis tribe. The southern species, *Gastridium australe*, called by the older botanists *Milium lendigerum*, is an annual grass of the sandy fields of some parts of Britain, and possesses a degree, though but a small one, of agricultural value. Its stem is smooth, branched from the bottom, and only a few inches high; and its flowers are produced in an erect, spiked, dense panicle.

GASTRITIS. Inflammation of the stomach. Gastritis, however, does not include the effects of mechanical distention of the stomach, or the irritating action of poisons, acrid substances, or improper food; but is simply idiopathic inflammation of the stomach's mucous surface. This disease sometimes occurs in the horse; yet is generally so combined with enteritis, and so closely similar to that disease in symptom, as to be very difficult of separate detection. A horse attacked with it loathes his food, is extremely restless, evinces great distress, lies down and suddenly rises, has fits of cold perspiration, and seems to suffer prolonged pain after swallowing any food; and he must, in all outward respects, be treated in the same manner as for enteritis, but must receive no internal remedies except such as are eminently sedative.

GASTROLOBIUM. A genus of ornamental, evergreen, Australian shrubs, of the sophora division of the leguminous order. The two-lobed species, *G. bilobum*, was introduced to Britain about 40 years ago; and is a yellow-flowered, spring-blooming shrub, of about two feet in height. The blunt-leaved species, *G. retusum*, was introduced about 15 years ago; and has a height of about 20 inches, and carries orange and scarlet flowers in May. The name gastrolobium alludes to the belly-shape of the pods.

GAS-WATER. The crude ammoniacal water of the public gas-works. "It is probable," said Mr. Handley in 1839, "that the ammoniacal liquor which abounds in gas-works, and which, when formerly allowed to run waste into the Thames, was said to destroy the fish, and prejudice the quality of the river-water for human consumption, and which is still thrown away throughout the country, except at a few works where they manufacture volatile ammonia, will, ere long, be extensively used as a manure, either through the intervention of the water-cart, or by the process of saturating and decomposing soil or vegetable matter. A very satisfactory illustration, on a small scale, has recently been submitted to the English Agricultural Society by the intelligent curator of the Polytechnic Gallery, Mr. Pain. He put into a vessel some leaves of trees, saw-dust, chopped straw, and bran, to which he applied ammonia, and closed it up. In about three weeks, the whole was reduced to a slimy mass; he then stirred it, and added a little more ammonia; and when submitted to the Society, it was reduced to a black mass of vegetable mould, strongly impregnated with volatile salts, and in comminuted particles similar to surface peat-mould." See the article Ammonia.

Gas-water varies in ammoniacal strength with the quality of the coals, the state of dryness in which they are used, the temperature at which the retorts are ignited, and the structure and volume of the condensing apparatus; and it may be obtained at the public works in different and well-defined degrees of strength; but, in its native and crude state, it contains ammonia in only a volatile condition, so as to be both caustic and very fugitive, and always holds in combination a pernicious and even poisonous amount of tar and naphtha. It is directly applicable only to permanent pasture; and even in that case, it requires to be diluted, and must be applied early in spring; and it will temporarily scorch any verdure which exists at the time of its application. The dilution of it not only adds to the cost of applying it, but allows it to retain all its deleterious admixtures.

But gas-water, neutralized with sulphuric acid, so as to have its volatile ammonia converted into the sulphate, is at once an economical, a mild, and a most available manure; and, while thus deprived of both its causticity and its fugitiveness, it may be so prepared in even small gas-works, as to be freed also from the greater part of its tar and naphtha. "The best way in such cases," suggests Mr. Shier, "is to have a double set of tar-wells, so constructed as to act as tar and naphtha separators. When one set is filled, the liquid products of the hydraulic main are directed into the other, so that they may accumulate in it while separation goes on in the first. After standing a few weeks, the naphtha holding some tar in solution may be run off from the upper chamber; after which, the water, now tolerably clean but of a brown tint, may be run off into a vat or tank, leaving the tar in the bottom. The ammoniacal water is next neutralized with sulphuric acid, and allowed to stand for a few days; some finely powdered resin is sifted on the top of the liquid; in a few hours, the resin can be removed in a soft viscid mass, taking along with it a portion of the dissolved naphtha, which the heat evolved on the addition of the acid serves to separate and bring to the top."

Yet the method of dealing with gas-water, most advantageous for both the manufacturer and the farmer, though economically practicable only in large or middle-sized gas-works, is to deprive it of all its ammonia by means of sulphuric acid, and reduce the proceeds into the crystallized sulphate. So valuable is the sulphate of ammonia as a direct manure, that it has been extensively prepared for the farmer's use from urine,—though, in this case, it takes along with it into its crystals the other fixed salts of the urine, so as to be but principally the sulphate of ammonia, and really a compound salt; and it exists naturally in the soot of coals, and is a main ingredient in the well-known manurial power of that substance. Sulphate of ammonia, as obtained from gas-water, is of very easy preparation; and though generally rendered very foul in both colour and smell by the presence of some tar and thickened naphtha, it looks and smells far fouler than it really is, and seldom contains even a slightly pernicious proportion of these unwelcome admixtures. But if the sulphate be prepared by gas-manufacturers who are ill-acquainted with the principles of their vocation, and know little or nothing of scientific chemistry, the sulphuric acid employed in the manufacture may be somewhat in excess, so as not only to neutralize all the alkali in the liquid, but attack the iron of the evaporating pan; and in this case, the resulting sulphate will contain some iron, and may be not only useless to the farmer but absolutely noxious. The presence of a considerable proportion of iron is easily detected by the green tint of the newly-made salt, the dark tint of the salt when kept for some time, and the redness of its tint when laid open to exposure. A perfectly or nearly pure sulphate of ammonia from gas-water is obtainable only by tolerable skill and considerable care; and even when obtained, may probably be surreptitiously combined by the manufacturer with a large proportion of Glauber's salt. "I have met with some specimens of sulphate made from gas-water," says Mr. Shier, "of fine colour, and in unusually large crystals, that contained a large quantity of sulphate of soda, which had obviously been added as a make-weight. Salt of this kind assumes a floury appearance when dried, or exposed for a few days in a dry atmosphere. The impurity is better detected by cautiously igniting a little of the sulphate on a slip of platinum foil, when the sulphate of ammonia will rise in vapour, leaving the fixed salt behind." See the article SULPHATE.

GATE. A gate has the same relation to a field or other enclosure which a door has to a house; and ought to combine the properties of a good fence with strength, stability, convenience of situation, and the utmost facility of opening and shutting. Many gates are either so slight as to be easily overleaped or broken through or thrown down; many are so ill-hung and ill-latched, that some horses and horned cattle can successfully assail or even readily open them; many are so ill-constructed or feebly poised, that they soon decay, or become ricketty, or cease to be easily opened and shut; and many are so inconvenient or otherwise so exceedingly faulty as to accomplish very imperfectly, or scarcely at all, the designs of their erection. Nearly all farmers have been more or less plagued with bad gates, and are aware how grievously they occasion injury to land and crops from the trespasses of cattle; and they must therefore be glad to know, that perfectly good gates differ from abominably bad ones, far less in the costliness of either their materials or their workmanship, than in the mere skill with which they are constructed.

A gate, when suspended by hinges, is a lever with the weight placed between the power and the fulcrum,—the gate itself being the weight, the hand applied to the head of it the power, and the hinges the fulcrum or centre of motion. If the hooks or pivots on which it is hung be precisely perpendicular to each other, the gate in every possible position will be at rest, and the same power which is required to move it through any given arc of the circle will be exactly sufficient to move it through any other arc of the same extent, or to bring it back to its former position; but if the hooks or pivots mutually deviate in even the smallest degree from the perpendicular, the gate will have one determinate line of rest, and must have a constant tendency to fall to that line from any part of the circle which it may be made to describe. "This," remarks Mr. Parker in his Essay on the Construction, Hanging, and Fastening of Gates,—"This opens a wide field to the wheel-wright for the exercise of his judgment; as, in determining that variation, he may direct his hammer through all the points of the compass, till he gains by accident what shall seem to answer his purpose; and were you minutely to observe the operation of hanging a gate, you would often believe that the practitioner was trying an experiment rather than pursuing any regular method." A gate whose hinges are not perpendicular to each other, has its line of rest at the point where it approaches nearest the ground; and when moved thence half a circle to the right or the left, it will there attain its greatest elevation, and there either will support itself, or may be kept poised by means of a very slight resistance. When a gate is in its line of rest, whether that be any line whatever within the circle of its motion, or one determinate line at the point where it approaches nearest the ground, or the line of equilibrium at the distance of half the circle from the one determinate line, the hooks or pivots on which it is suspended are in the same vertical plane with the centre of the gate's gravitation. The truth of this, in the case of a gate whose hooks or pivots are perpendicular to each other, is quite apparent in the fact of the gate having perfect rest on any one line whatever within the whole periphery which it describes; and, in the case of ill-hung gates, it may be known simply by observing the action and gravitation of such as have their hinges adjusted in the most awkward or perverse manner.

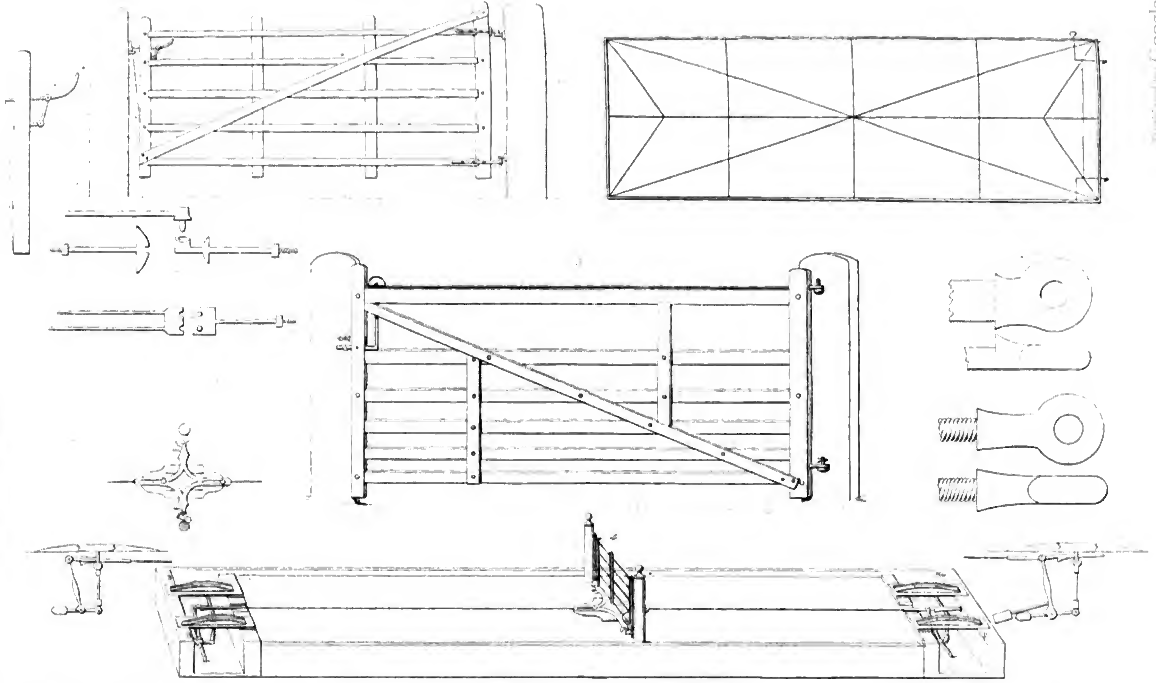
A gate which is little used, or is commonly kept locked, or cannot conveniently be held open when wanted, may be hung upon hooks or pivots perpendicular to each other, so that it may stand at rest on any line whatever; but a gate which is merely latched, and which serves as part of the fence of a grass-field or of a cropped enclosure, ought to be hung upon hooks or pivots which give it one determinate line of rest in the direction of the latch, so that, whenever it is opened, it may have a self-shutting action. The carelessness of farm-servants and others, who will rather leave a gate open than take the slight trouble of shutting it, admits of no efficient corrective except to give the gate the power of shutting itself; and any disadvantages which might occasionally result from that power, can easily be counteracted by means either of a temporary prop-stone or of a permanently sunk stone with a simple hook or latch on its summit. A good line of fastening is one-sixteenth part of the circle short of the line of rest,—giving the self-shutting power a proper degree of momentum or velocity, and occasioning the opposite line of equilibrium to be one-sixteenth part of the circle short of the gate's greatest extent of opening; and in order to prevent the self-shutting power from being at any time destroyed by the advance of the gate to the line of equilibrium, a short post or permanent obstruction ought to be placed at about half the distance between the road to be passed and the fence adjoining the hanging-post, or about one-sixteenth part short of the line of equilibrium, so that the gate may never recede farther than about three-eighths of the circle from its line of fastening. A gate thus hung needs no oiling of its hinges in order to maintain its self-shutting power; and when baffled and held back for a time by the force of a high wind, or by the hand of man, or by any other agency, it will no sooner be let free than it will return to its fastening. The control of wind over its self-shutting power is an irremediable evil, and is even greater in the case of a good gate than of a bad one, on account of the comparatively broader extent of surface; but if the velocity or momentum of the fall were made equal to the resistance of so strong an agent, the gate would speedily and frequently want repair, on account of the constant violence of its shutting.

The posts of a gate must be of sufficient length and strength; and if fixed at the distance from each other of 8¾ feet, they will be adapted for a one-side-opening gate of 9 feet, or of 9 feet 2 inches, including the thimbles. Let the gate be supported where it is to hang and fasten; and then drive in the upper hook at a convenient distance from the edge of the hanging post, so that the upper hinge shall not be in the way of any vehicle passing the road, and yet be so near the edge of the post as to lose no more room for the road than is unavoidable, by the head and heel extending a little upon the posts. The heel, indeed, does not need to extend upon, or lap against, the hanging-post; but as the head ought to meet the falling-post, at the least with half its own substance, or from that to two inches, the heel may, for the sake of uniformity and neatness, make a nearly equal advance upon the hanging-post. The hinges of a good road-gate ought to be 40 inches apart from each other, and those of every other gate as far apart as is consistent with its form, and care must be taken not to spoil the mortises or weaken the heel of the gate, by the manner of inserting the thimbles. When the upper hinge is fitted, the gate ought to be supported upright for adjusting the place of the lower hook to that of the lower thimble; and when both hinges are fitted, two plumbed lines, with fine threads and heavy even-sided plumbs, must be used to ascertain whether the hooks be in their exactly proper position. "If the hooks are well finished, the observation respecting the centre may be taken by fastening the plumbed lines round the hooks, and letting them fall from the outsides of similar parts of the hooks. Forty inches being the given distance of the hinges, the horizontal distance of the two lines falling from the hooks should be 1¼ inch, and in a line which forms an angle of 22½ degrees, or one-sixteenth of a circle, with the gate's line of fastening. Take therefore a common two-feet rule; and having opened the legs to the angle of 22½ degrees, place one side of it against the plumbed lines, which ought to answer to the measure of 1¼ inch, while the other leg of the rule should be parallel to the gate's line of fastening. A slight blow or two with a hammer on one or both of the hooks in the direction necessary, will complete the adjustment."

Gate-posts ought to be so firmly set in the ground as to resist all tendency to decline from their perfectly upright position. The constant weight of the gate tends to pull the hanging-post inward; the fall of the gate, and its frequent infliction of blows in shutting, tend to drive the falling-post outward; and the passing of heavily-laden carts or waggons or other wheeled vehicles near the posts tends to disturb the foundation of both posts. A slope of the ground adjacent to the gate-posts, whether the slope be natural or artificial, tends to make them nod in the direction of the slope; so that the posts of a gate across the ridge or summit of a hill are liable to decline outward, the posts of a gate across the bottom of a hollow are liable to decline inward, and the posts of a gate across a terrace-road upon the face of a declivity are liable to decline, the one outward and the other inward, both stooping in the direction of the declivity. The opposite effects of scorching heat and intense cold, of excessive rain and extreme drought, aided by the shaking action of vehicles passing along the road, also cause the ground around the posts to make fresh settlings, and tend to work the posts toward the natural descent of the surface. One tolerably good contrivance for counteracting the tendency of the posts to decline from their proper position, is to place coarse heavy props against the underground portion of the posts, in such a manner as to exert their forces in the opposite direction to that in which the tendency operates; another, is to mortise the pair of gate-posts together by cross pieces of timber under the road; and a third, and still better, because both cheaper and more secure, is to let down the posts very deep into the ground, and allow them to have a natural basis too strong and remote to be affected by any or all of the forces which tend to draw or push or shake or wile them from their proper position.

In determining the side on which a one-side-opening gate is to be hung, regard must be had to the situation of the approach to it, to the nature of the spot on which it will fall when opening, to the prevention of all inconvenience by the manner in which it shall stand open, and to the affording of plenty of room for the driver of a refractory horse, or for a man on horseback, holding back the gate while a cart or waggon or other wheeled vehicle passes. When other considerations are not paramount, the gate ought to be made to open against the side from which the trespass of cattle may be most apprehended. But in some doubtful or difficult cases, hooks should be fixed on both sides of the hanging-post, so that the gate may be shifted from the one side to the other, to suit convenience or the change of circumstances.

Good gates, all equally suitable for different purposes or in different situations, vary widely from one another, at once, in the form of the gates themselves, in the modes of their adjustment to the posts, in the materials of which gates and posts consist, and in many of the characters of position and fastening. Even good gates of communication with public roads—the class which we have hitherto had particularly in view—may differ from one another in size, material, form, and height, in modes of hanging and fastening, in being one-sided or two-sided in their opening, and in some other important characters. All kinds of gates of farm-communication with public roads, again, may differ from gates of communication between field and field; and both these classes from all kinds of turnpike-gates; and all the three classes from all kinds of factory and urban-gates; and all the four classes from all kinds of park-gates and pleasure-ground-gates. Yet all thoroughly good gates for almost any part of either the farm or the farmery, must conform, either altogether or very nearly, to the general principles which we have stated. Every good farm-gate, too, ought to be so constructed as to throw the heaviest parts of it as much as possible toward its heel; and therefore its rail and bars are best formed when their parts are tapered on every side. A gate communicating between a field and a public road ought to be comparatively high and to have upright pales sharpened at the top, or to possess some other such construction as will prevent it from being easily climbed over by a human trespasser. Such a gate, also, may properly enough be made double, in the manner of folding doors, and may have its suspension hooks placed exactly perpendicular to each other, so as to make either part of the double gate remain at rest in any one line whatever of the great arc it describes in opening. A gate of communication between field and field is preferred by some persons to be light and high, and by others to be low and heavy; and it is recommended by many to be about 4½ feet high, in order that it may serve as a good fence against horses, having its top-rail as high as their wind-pipe, and allowing them to put their head over it, and not provoking them to push or force it with either their breast or



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their rump. When wood is used for posts, any coarse kind, whether fir or hardwood, which is unfit for other useful purposes, may, in most instances, be sufficiently good. When stone is used, a single pillar-piece of granite, compact greenstone, or any other hard crystalline rock, is best; and if the gate be hung on the front of it, the bands of the hinges, instead of being indented into the stone, ought to be carried through to the opposite side, and there fixed by a bolt or a screw-nut. When timber is used for the gate itself, Scotch pine is utterly unsuitable on account of its excessive perishableness when exposed to the weather,—spruce is unsuitable on account of its great liability to break,—larch is unsuitable on account of its powerful tendency to warp,—and if some kind of soft and cheap wood must be employed, the least objectionable is Memel timber; but the best, in all respects, is elastic oak, not too tough, and entirely free from sap. All the mortises of the gate, and the parts at which the uprights and the diagonals cross the bars, ought to be carefully coated with white lead; and when the parts of the gate are joined together, the whole ought afterwards to receive two coats of paint.

In *Plate XXII. Fig.* 1. is the representation of a one-side-opening road gate, constructed on the principles which we have laid down, and applauded by Mr. Parker, in his Essay on Gates, as the best design of farm gates with which he was acquainted. The timber used is oak; the bars are let into the middle parts of the head and heel; and the braces are tapered for finishing upon a level surface with the heel, head, and rail. The heel measures 4 feet 4 inches in length, 4½ by 3½ inches in greatest thickness, and 832 cubic inches in solid contents; the head, 4 feet 4 inches in length, 2½ by 2½ inches in greatest thickness, and 325 cubic inches in solid contents; the rail 9 feet in length, 3½ by 3½ inches in greatest thickness, 2½ by 2½ inches in tapering to the head, and 972 cubic inches in solid contents; each of the five diagonal bars 9 feet in length, 3½ inches by 1 inch in greatest thickness, 2½ inches by ¾ of an inch in tapering to the head, and 1417½ cubic inches in solid contents; the diagonal brace 9½ feet in length, 3½ inches by 1½ inch in greatest thickness, 2½ inches by 1 inch in tapering to the head, and 427½ cubic inches in solid contents; the larger upright brace 2 feet 8 inches in length, and 3¼ inches by 1¼ inch in greatest thickness,—the smaller one 2 feet 8 inches in length, and 3 inches by 1¼ inch in greatest thickness,—and the two together 250 cubic inches in solid contents. All the eight parts at the head present to the eye 2½ inches; and seven out of the eight at the heel, that is, all except the heel itself, present 3½ inches. The diagonal brace is fitted into the heel by a strong butment on a line with the lowest bar, and meets the upper angle at the head, and is laterally confined by the two upright braces. An iron strap, of the whole length of the gate, and placed along the top of the rail, powerfully assists in giving strength and stability to the entire structure,—particularly in suspending the frame of the gate, in keeping up the rail, in preventing the head from being pushed forward, in resisting the force of violence in shutting, in relieving the heel of a great part of the weight of suspension, and in preventing strains on the mortises from either the gate's own weight or any occasional pressure or violence. This strap commences at the upper thimble, and forms a part of it, and holds the heel of the gate by the shoulder of the thimble; it is then screwed to the rail, at proper distances; and it terminates at a screw-nut, rounded and let into the gate's head. It is about half an inch square, close to the shoulder of the thimble; it maintains a proportionate strength over the next four inches; it has a thickness of about a quarter of an inch over one half of its total length; and it thence tapers toward the head of the gate; but it has its edges chamfered off, and it appears on the whole to taper gradually from heel to head, widening a little round the hole which is left for the upright part of the latch adjoining the handle. The upright wire of the latch is furnished with a guard; and the mortise of the head through which the latch passes, is finished with sheet-iron escutcheons.

A gate of a somewhat different pattern from the preceding, lighter, much cheaper, and equally well suited to the majority of situations on a farm, may be constructed on the same principles, and with very nearly the same supereminent power of resisting all tendency to sink at the head. It has a mere bar instead of a rail, five other bars, two diagonal braces crossing each other in the centre of the frame upon the third bar, and two small upright braces, the one connecting the two upper bars and the other the three lower ones, on a line with each other and with the cross of the diagonal braces. The heel measures 4 feet 4 inches in length, 3½ by 3 inches in thickness, and 588 cubic inches in solid contents; the head, 4 feet 8 inches in length, 2½ by 2½ inches in thickness, and 340 cubic inches in solid contents; the first, third, and sixth bars, 9 feet in length, 3 inches by 1 inch in thickness, and 972 cubic inches in solid contents; the second, fourth, and fifth bars, 9 feet in length, 2 inches by 1 inch in thickness, and 648 cubic inches in solid contents; the two diagonal braces 9½ feet in length, 2½ inches by 1 inch in thickness, and 285 cubic inches in solid contents; and the two upright braces, 2¾ feet in length, 2½ inches by 1 inch in thickness, and 82½ cubic inches in solid contents. The quantity of timber in this gate, therefore, is only about seven-tenths of the quantity in the former. All the rivets ought to be made of ⅓ inch wire, the heads ¾ inch diameter; and the washers of strong sheet-iron, rounded or punched into form, and of the same diameter as the head; and when a rivet is driven into its place, the washer should be put on the reversed side, and the end of the rivet cut off to the exact length required. But nails may be used instead of rivets, if they be thought more economical. The two diagonal braces ought to be mitred into the head and the heel, and united to them with a planed surface; and as the head is only 2½ inches thick, the braces must be reduced a little at the ends connected with it, so as to bring them to a finish level.

A neat, economical, and durable swing-gate of considerably different construction, and now not uncommon in paddocks and home-grounds round the houses of country gentlemen, and well suited for most of the ordinary enclosures of the farm, is represented in *Fig.* 2. *Plate XXII.* Its length from head to heel, inclusive of these, is 9 feet; its height over the bars is 3¾ feet; the distance between the head and the falling-post is 3 inches; the distance between the heel and the hanging-post is 5 inches; the distance of the lower extremity of the head, heel, and upright braces from the ground is 2 inches; the projection of the head, heel, and upright braces below the lowmost bar is 4 inches; the projection of the head and upright braces above the topmost bar is 6 inches; and the projection of the heel above the topmost bar is 12 inches. The head has a thickness of 3 inches by 3, and the heel of 4 inches by 3; and the extremities of all the five bars are mortised into these. The bars have a thickness of 2⅜ inches at their junction with the heel, and taper to a thickness of 2⅛ inches square at their junction with the head; and they may all be bevelled a little at top. The upright braces have a thickness of 3 inches by 1¼, and consist of pieces of plank, nailed to one side of the bars; and the diagonal brace has the same thickness, and is nailed to the opposite side of the bars. The upper hinge *a a*, fixed on the topmost bar, is formed with a band or crook in the common manner, and is received into the socket of the hinge, *b b;* and both this hinge and the lower one are indented into the post if it consist of timber, but carried through to the opposite side, and there fixed by a bolt or screw-nut, if the post consist of stone. The advantages of making the upper hinge move in a socket, are that, while space is given it to play, it is firmly supported in its place, and that opportunity always exists for correcting any stiffness or reluctance in its motion by smoothing the socket with a little oil. The lower hinge affords two pivots or points of support to the lower part of the gate; and consists of two iron plates placed horizontally at the distance from each other of three-eighths of an inch, the upper of which *c* is fixed to the post, and the lower *d* to the gate. From the under side of the upper plate, at *r r*, project two cylindrical pieces of iron, or knobs, placed perpendicularly; and these are received into the grooves or hollows *i i* of the lower plate, and there support the gate in the capacity of pivots. When the gate is shut, therefore, it has three distinct points of support,—the socket of the upper hinge, and the two pivots of the lower hinge,—and these three are situated at the angles of an isosceles triangle, the socket at the vertex, and the pivots at the base; and when the gate is open, it has only two points of support, the socket and one of the pivots. But support on the two pivots is equivalent to support on a point perpendicular to the socket, while support on only one of the pivots is equivalent to support on a point not perpendicular to the socket; so that the gate is on the line of rest only when shut, and possesses a self-shutting power at any point between that line and the opposite one of equilibrium. The more distant the socket is fixed from the lower points of support, the more firmly is the gate retained in its place, and prevented from trailing on the ground; and the more distant the lower points of support are from each other, the greater is the momentum or velocity of the gate's self-shutting power. The upper hinge, therefore, ought, as directed, to be placed on the topmost bar of the gate; and the two pivots or knobs, as also the corresponding grooves, of the lower hinge, may be formed at the distance from each other of 5 inches. A gate thus hung, however, can be opened very little beyond the quadrant of a circle without losing its tendency to regain its position; and it requires to have a latch which will shut and open with the least possible force. The spring *k*, two feet in length, is fixed nearly at right angles to the piece of iron *e*, which passes through the bar of the gate, and is attached to the handle by a joint or hinge fixed to the handle at *m*, while the handle itself is attached to the back of the bar by a similar joint at *n*. The groove in the horizontal plate *p*, for the reception of the spring, must be in the plane of a perpendicular from the upper hinge. The plate for receiving the spring of the latch, is 11 inches in horizontal breadth.

A field-gate of a very good kind, and considerably akin to the first and the second which we have noticed, is figured and described in the 7th Volume of the Highland Society's Transactions, and has been a good deal recommended. It measures 10 feet in length and 4 feet in height; it has a head, a heel, four principal bars, one subordinate bar, two upright braces, and one diagonal brace; and it is hung, not on the front but on the side of the hanging-post, and has therefore the character, not of a swing-gate, but of a one-side-opening gate. Its four principal bars taper from a thickness of 4 inches by 1¼ inch at the heel to a thickness of 3 inches by ¾ inch at the head; and its subordinate bar is slender, and has an uniform thickness, and is placed between the third and the fourth principal bars, simply to prevent the egress of lambs. The two upright braces extend from top to bottom of the gate, at one-fourth of the total length of the gate from respectively the head and the heel; and the diagonal brace extends from the upper end of the head-ward upright brace to the lower end of the heel-ward upright brace, and is there adjusted at so advantageous an angle as scarcely to require either nail or rivet to keep it in its place. The hinges are placed respectively a little below the topmost bar and a little above the lowmost bar; and, in consequence of being distant from any joining of the wood, they do not occasion any of it to rot. Each part of the lower hinge is 1½ inch longer than the upper, and the upper shortens by means of a screw and nut; so that the gate has a self-shutting power except when three-quarters open, and if its head should sink, the upper hinge will take it up.

Cast-iron gates, of great variety of forms and patterns, and often with beautiful and elaborate devices, have been long and extensively in request for ornamental situations; but, even in their simplest, lightest, and cheapest form, they are too heavy, too frangible, and too expensive to be suitable for any of the enclosures of the farm. Gates of wrought iron, principally in the form of bars and rods, have likewise been much used for combining elegance with utility, and have, for a considerable time past, been commending themselves to somewhat extensive adoption among farmers; and whenever they can be erected as cheaply as substantial wooden gates, they unquestionably deserve the preference. Gates, in particular, which consist of a frame of light iron bars and a filling up of wires or of small iron rods are specially worthy of notice, and may be so constructed as singularly to combine the properties of cheapness, lightness, strength, durability, and beauty. Both field wire gates and fancy wire gates, of eminent adaptation to their respective purposes, and largely possessing the properties which we have named, were contrived, a considerable number of years ago, by Mr. George Buist of Fifeshire. The principle on which he constructed them was, that all the portions requisite for filling up a gate, and which generally make a serious addition to its weight and cumbrousness, should assume the office of stays or strengtheners to brace up the frame, and that, being all exposed to merely a longitudinal strain, they should consist of strong wires or very small iron rods, which, when exposed to nearly the direction of their greatest strength, would sustain without injury a pull of four or five times stronger force than any which the gate might ever be likely to receive.

One of the simplest and cheapest of the wire gates, which may be viewed also as the skeleton of the more complex and expensive ones, is represented in *Fig.* 3, *Plate XXII.* This gate is 9 feet long and 3 feet high; it weighs about 80 lb.; and seven or eight years ago, it could be made and put up for about £1 8s.,—a price considerably lower than was then commonly charged for an ordinary wooden gate. The framing, *a b c d*, is of light bar iron, put together in the usual way; *e f*, *g h*, and *k l* are light straps of iron, fastened at the ends by rivets to the upper and lower rails, and serving both to tie these rails together and to strengthen the entire frame. The whole of the other fillings-up consist of wire or rod iron, about the thickness of a goose quill: *a c*, *d b* are diagonals for the purpose of maintaining the gate in a rectangular form; *a q b* is a back-stay or brace for *a b*, to prevent it from bending downwards by pressure—it passes through punched holes in the straps *e f*, *g h*, and *k l*, so that *a b* is stiffened by it at the three points *e*, *g*, and *k;* in like manner, *d r c* is a back-stay similarly arranged in reference to *d c*, to prevent it from yielding upwards. The three straps, *ef*, *g h* and *k l*, connect the two rods together, and give each of them the supporting power of both back stays either way: that is, *a b*, as already shown, is prevented yielding downwards by its own proper back stay *a q b*, and it is prevented yielding upwards by the back stay of *d c*, that is, *d r c;* and so with *d c*, whose depression is prevented by the stay *a q b*, to which it is tied by the straps. So, in like manner, with reference to the ends of the gate, the stays *a t d* and *b s c* come into operation. Now these, when combined as in *Fig.* 3, give such a system of universal bracing, that the framing, strengthened by them, can be disshaped by no force short of one of sufficient power to lengthen out the wires longitudinally. They form a gate, not adequate, certainly, for the retention of lambs or pigs without some additional wires, but which will keep in cattle of every sort, its largest apertures being only a triangle 15 in. by 9 in. Any sort of lock or hanging may be used which seems expedient. When a gate is suddenly shut, it will be observed to tremble and vibrate violently for some seconds, at the fore part or lower part farthest from the crook end. This, like every other kind of concussion, is of course injurious to the structure of the gate. To remedy this, and also overcome the chance of the gate catching, two latches are here employed, one at the top and one at the bottom of the gate. This fastens the gate at once at both extremities. They are coupled together by a wire, so as to lift simultaneously on pressure at the handle above.

Various kinds of self-acting gates, such as open of themselves when a carriage approaches, and shut of themselves when the carriage passes, have been constructed; but most have been either too complicated in their machinery, or too resistive to the application of a moderate force. They are desirable chiefly in approaches to mansion-houses, in roads through gentlemen's parks, or on the main thoroughfare of very extensive farms, where convenience or economy would be materially sacrificed by the necessity of a manual opening and shutting of the gate on every occasion of the passing of a carriage. But they must be so constructed as not to exercise their self-acting power under the tread of horses or oxen, and as always to exercise it under the pressure of the wheels of even the lightest ordinary carriage; for were they to open under the tread of animals, they would not serve as fences,—and were they not always to open under the pressure of carriage-wheels, they might occasion serious injury by collision with the draught-horses.

One of the best self-acting gates ever yet contrived was invented about 17 years ago by Mr. Robert Russell of Denny Loanhead; and is represented in *Fig.* 4, *Plate XXII.* The machinery of its self-action is situated under the road at the distance of 40 or 50 feet from it, and is connected with it by a rod; it comprises an apparatus on the one side for opening, and an apparatus on the other side for shutting; and it has, on each apparatus, two tracks for the wheels of a carriage, similar to those of a weighing-machine, and level with the road at their extremities, but rising a few inches above it in the centre. When a carriage arrives on the tracks of the opening apparatus, its weight depresses them, turns a lever under the ground, and makes such a pull upon the connecting-rod as to open the gate, and fling it back upon a latch; and when the carriage has passed the gate, and advances on the tracks of the shutting apparatus, its weight acts in a similar way, through lever and connecting rod, to release the gate from the latch, and to let it fall back to its place. The gate, in its state of rest, is kept shut by the machinery; but, by means of a spring-catch, it can, at any time, be opened or shut by hand. The inventor calculated, 17 years ago, that a gate of this kind, together with all its appurtenances, would cost about £25.

GATHERING. The rolling of corn-swathes into cocks; the picking of part or whole of a crop of fruit from fruit-trees; the collecting and lifting of unearthed potatoes or other roots in the drill; the picking up of stones, weeds, or other injurious substances from the surface of land; the pulling of flowers and the collecting of them into a bouquet; and any one of several other simple rural operations of aggregating a number of individual objects by hand.

GAUDINIA. A hardy, perennial grass, of the wheat tribe. It constitutes a genus of itself; and is specifically called *fragilis* or brittle. But though naturally allied to wheat, it was ranked by Linnæus as an oat, under the name of *Avena fragilis.* It was introduced to Britain from Spain about the middle of the latter part of last century; and it usually has a height of about 20 inches, and flowers from June till August; but it possesses little value.

GAULTHERIA. A genus of ornamental shrubs, of the heath family. The procumbent species, *G. procumbens*, is a very handsome, hardy, evergreen, ligneous creeper, carrying white flowers from July till September; and was introduced to Britain, upwards of 80 years ago, from North America.—The wild-thyme-leaved species, *G. serpyllifolia*, a hardy, fructiferous, evergreen, ligneous trailer, introduced about 30 years ago from Hudson's Bay, has been called by some botanists the filiform arbutus, and by others the rather hispid whortleberry, and will probably take a permanent place among the cranberries, under the name of *Oxycoccus hispidulus.*—The Shallon species, *G. Shallon*, is a hardy, upright, evergreen shrub, introduced about 20 years ago from North America, attaining a height of 4 or 5 feet, and carrying white flowers in May.—Two greenhouse, evergreen shrubs, of 6 or 7 feet in height, the fragrant and the antipodal, have been introduced from Nepaul and New Zealand; and upwards of a dozen others are known to botanists.

GAURA. A genus of beautiful plants, of the fuchsia and clarkia family. The changeable species, *G. mutabilis*, is a very handsome, yellow-flowered, late-blooming biennial, of about 2 feet in height, from North America; the narrow-leaved species, *G. angustifolia*, is an elegant, pink-flowered, late-blooming, hardy, evergreen herb, of about the same height as the preceding; and the small-flowered species, *G. parviflora*, is a very beautiful, hardy, late-blooming, North-American biennial, with intense rose-coloured flowers, and a height of 4 or 5 feet. Another hardy biennial, a hardy evergreen herb, and a tropical evergreen undershrub, all handsome, were introduced previous to 1817. The name gaura alludes to the magnificent appearance of the flowers.

GAVEL. Ground; also a swarth of corn cut down by the scythe.

GAVELKIND. A law of equally dividing the land of a father, at his death, among all his sons. This law prevailed anciently in Kent, in Wales, and in some subordinate English districts; and it still is frequently observed in Ireland; and it likewise continues to possess such semi-dormant force in Kent, that lands which cannot be proved to exist upon some other tenure, are assumed to be subject to gavelkind. The division of land among children, the subdivision of it among grandchildren, and the continued redivision of it among succeeding generations as long as redivision can be practised, is alleged to have operated as a powerful obstacle to the improvement of many parts of Ireland. But the moral influences of small tenures in that country seem to us to be closely akin to the moral influences of small tenancies; and though wretchedly cultivated tracts unquestionably pine and sicken in the possession of very small proprietors, tracts of enormously greater extent also pine and sicken, or are even famished into sterility, in the possession of wealthy and aristocratic landowners. Gavelkind, when estimated as a controlling power over the condition of a country or a people, ought to be viewed, not by itself, but only as one of several or perhaps numerous great powers which operate combinedly with it upon both mind and land.

GAVELOCK. An iron bar for fixing stakes into the ground.

GAW-FURROW. An oblique furrow, or small oblique trench, acting as a surface drain. See the articles DRAINING and PLOUGHING.

GAZANIA. A genus of brilliantly-flowering, Cape-of-Good-Hope plants, of the sunflower division of the composite order. Three evergreen herbaceous species, and two evergreen undershrubs, all less than 15 inches in height, and carrying yellow or orange-coloured flowers, were introduced previous to 1820; and four or five other species were then known. The name gazania is intended to signify "richness," and alludes to the superb appearance of the flowers.

GEAN, or GUIGNE,—botanically *Cerasus Avium Sylvestris.* The wild or forest variety of the bird cherry-tree. It is indigenous in the woods of both England and Scotland, and usually attains a height of 50 or 60 feet; and is esteemed at once by the peasantry for its fruit, by the cabinet-maker for its timber, and by the landscape-gardener for its elegant form and interesting appearance. "It may very well be considered a forest-tree," says Sir Thomas Dick Lauder, "seeing that, in many parts of the wilds of Scotland, it is almost as numerous, and propagates itself as fast as birch. It grows, moreover, to be a very handsome timber-tree; and the wood of it makes very pretty furniture. In form, it is oftener graceful than grand; and its foliage is rather too sparce to produce that tufty effect which gives breadth of light and depth of shadow enough to please the painter's eye. But on the cliffs of romantic rivers, such as the Findhorn and other Scottish streams of the same character, where it is stinted of soil, it often shoots from the crevices of the rocks in very picturesque forms; and the scarlet of its autumnal tint, when not in excess, sometimes produces very brilliant touches in the landscape, when the neighbouring trees happen to be in harmony with it."

GEATE, or HUMATE. A salt formed by an alkaline base with geic or humic acid. See the articles GEINE and HUMIN.

GEERING. The harness of draught-horses, the rails and ladders of a waggon, the connecting wheel-work between the parts of a machine, and, in general, any group or series of artificial appliances for acting a subordinate or appendaged part to a chief moving power.

GEESE. See GOOSE.

GEINE. Humus. But some chemists use the word geine as a synonyme for all the varieties of sense attached by other chemists to the words humus, coal of humus, humin, humic acid, and ulmin; and they even impose upon it some additional meanings of their own, from the most widely generic to the most narrowly specific, till it is made to denote almost any thing connected with dead and decomposing vegetable matter in the soil. Dr. Dana, in particular, mixes talk about geine with almost all his agricultural chemistry; and yet, in his very definitions and descriptions, he speaks of it in so many senses as to bewilder ordinary readers. "There is," says he, "one constant product of organic decomposition in soil, which is ever the result of that process in or upon the earth; this product is termed geine." "While the great mass of organic matter of soil is a well-defined chemical compound, termed geine consisting of carbon, hydrogen, and oxygen, there are traces of other general products of decay which contain nitrogen. There is thus naturally pointed out a division of the organic matter of soil into two classes,—those which do not, and those which do contain nitrogen. The first class, or non-nitro, genous, comprises three substances, which have been termed,—first, extract of soil, or of humus,—second, geine, or humic acid,—and third, carbonaceous soil, or humin; these are chemically the same, passing from one state to the other, without changing the relative proportions in which they were combined. The second class, or nitrogenous, comprises two substances,—crenic and apocrenic acids. The distinction of geine into nitrogenous and non-nitrogenous, is founded in nature; these classes cannot eventually pass the one to the other." "Geine is as essential to plants as food is to animals; so far as nourishment is derived from the soil, geine is the food of plants." "In all its forms, geine is agriculturally one and the same thing; they are all included in the terms humus or mould or geine. Geine, in its agricultural sense, is a generic term; it includes all the decomposed organic matter of the soil. It concerns the farmer less to know the chemical constitution, than it does the practical agricultural value of a class of compounds termed geine." "It has been stated already, that geine is the product of decomposition of bodies once endowed with life; for the present purpose, it may be considered as the result of vegetable decomposition." "Putrefaction is the silent and onward march of decay; its goal is geine." "The original brown solution," of dry vegetable matters soaked in water, and afterwards exposed to the air till a sediment is formed, "may be considered as extract of mould,—the sediment as geine and carbonaceous mould; these are either soluble or insoluble in water or alkali,—and hence geine is divided into soluble and insoluble." Thus, in the course of a professedly definitional and explanatory statement, not long enough, even though quoted at full length, to fill one of our pages, geine is made to mean all food of plants from the soil, and therefore, saline as well as organic matters,—all decomposed organic substances, the results of putrefaction as well as of fermentation and eremacausis, and therefore animal as well as vegetable remains,—all decomposed vegetable matter, whether nitrogenous or non-nitrogenous, and whether soluble or insoluble,—all non-nitrogenous decomposed vegetable matter,—only one of the three non-nitrogenous substances in decomposed vegetable matter,—a whole class of compounds,—a genus of the proximate principles of soil,—only one substance in the class of compounds,—only one species in the genus. Such excessive confusion in the use of one of the most important terms in agricultural chemistry, should make us glad that we can afford to throw away the word altogether, and to employ a nominal but far more definite synonyme. See the articles Humus and Humic Acid.

GEISSOMERIA. A very beautiful, evergreen, Brazilian shrub, of the acanthus order. It constitutes a genus of itself; and is specifically called *longiflora* or the long-flowered. It was introduced to Britain about 20 years ago; and it grows about a yard high, and produces scarlet flowers in July and August.

GEISSORHIZA. See Tile Root.

GELATINE. One of the nitrogenous proximate principles of the bodies of animals. It abounds in many of the solid parts of animal bodies,—particularly in the skin, the membranes, the tendons, the cartilages, and the bones; but it does not exist in any of the healthy animal fluids. It is the principle of animal jelly, as pectin is of vegetable jelly. It readily dissolves in boiling water; it forms a hydrate or solidifying solution, which, when passing from the solving heat to the ordinary temperature of the atmosphere, becomes a tremulous, semi-transparent jelly; and so great and diffusive is its power, that a single pound of it will solidify or gelatinize one hundred pounds of water. The presence of so much water causes the jelly readily to liquefy on the application of heat, and the gelatinizing power of the gelatine causes it readily to resolidify on the return of cold; so that the jelly may many times be alternated between the liquid and the solid conditions, and still retain all its characteristic properties. But when the jelly, or any hydrate of gelatine of tremulous consistency, is kept for some time, it acidulates and putrefies; while jelly reduced to a perfectly solid state by the expulsion of its water by means of gentle heat, becomes a hard and brittle mass, and may be kept for any length of time without undergoing decomposition or change of properties. The animal jelly of the cook-confectioners is a thorough hydrate of gelatine, prepared from the tendons and ligaments of the feet of calves; the semi-pellucid and leather-like gelatine of the comfit-confectioners, is a slight hydrate of gelatine, and will keep comparatively long; the coagulating or thickening principle of the ordinary soups and broths of the kitchen, is gelatine in a state of too abundant solution to form a real or solid jelly; the common glue of commerce is the hardened or un-hydrated gelatine, prepared by boiling the cut skins, hoofs, ears, bones, and other gelatinous parts of quadrupeds in water, and afterwards expelling the water of the hydrate by the application of gentle heat; and isinglass is the hardened or un-hydrated gelatine, prepared from the swimming-bladder of the sturgeon and some kindred fish in a similar manner to glue from the gelatinous parts of quadrupeds. But only the last of these, or even isinglass itself when of the best quality, is pure or nearly pure gelatine; glue being mixed with fatty and other matters, which are dissolved in combination with the gelatine, and all the jellies of cooks and confectioners being more or less affected with either natural admixtures, or artificial admixtures, or both. Gelatine, as an article of food, has been extolled by some men as supereminently nutritious, and depreciated by others as but moderately nutritious; but in itself, or with no water, it is quite, or very nearly, identical in chemical constitution with animal albumen, and therefore must be more nutritive than even the white of eggs,—whilst in a state of ordinary jelly, or as a hydrate of 50 or 100 parts of water to one part of gelatine, it is of course just one-fiftieth or one-hundreth less nutritive than albumen. Gelatine, according to analysis by Gay-Lussac and Thenard, consists of 47·881 per cent. of carbon, 7·914 of hydrogen, 27·207 of oxygen, and 16·998 of nitrogen.

GELDER-ROSE. See-Guelder-Rose.

GELDING. A castrated animal. See the article Castration.

GELONIUM. A genus of apetalous, tropical, evergreen shrubs, of the euphorbia tribe. Three species, the bundled, the lanceolate, and the two-ranked, each about 6 or 7 feet high, have been introduced from India to the botanical collections of Britain.

GELSEMIUM. A very beautiful, hardy, evergreen, ligneous climbing-plant, of the dog's-bane family. It was long regarded as bignoniaceous, and even as a true trumpet-flower, and was called botanically *Bignonia sempervirens*, and popularly the evergreen trumpet-flower, the bergenia jasmine, and the bergenia climber; but it really belongs to the dog's-bane order, and has such peculiarities as to constitute a genus of itself. It combines the beauties of a jasmine and a bignonia with the properties of an evergreen and an exquisite climber; and it now bears the botanical name *Gelsemium sempervirens*, the latter designating its evergreen habit, and the former modelled from the Italian name of the jasmine. "It has almost every perfection," remarks Marshall, "to recommend it as a climber; for though the plants are small, yet if they are trained up to a wall, or have bushes or trees on which to climb, they will mount to a great height by their twining stalks, and overtop hedges and even trees, and will form at a distance a grand figure from the sway they will bear. The leaves are single and of a lanceolate figure; they grow from the joints, are of a fine, strong green colour, and very ornamental. But the flowers constitute the greatest value of this plant, on account of the fine odour Nature has bestowed on them,—which is to so great a degree as to perfume the circumambient air to a considerable distance; they grow in an erect manner from the wings of the leaves at each joint, and their figure nearly resembles that of a trumpet."

GELT-GIMMER. A barren ewe.

GENERATION. Under this term, physiologists comprehend the aggregate of functions which concur, in organized beings, towards the production of their kind. The birth of organized beings is the greatest mystery of organic arrangements, and indeed of all nature. We see organized bodies *develop* themselves, but they never *form* themselves; on the contrary, in all those cases where we have been able to trace them to their source, they are found to derive their origin from a being of similar form, but previously developed, that is, from a parent. The offspring is termed a *germ*, as long as it participates in the life of its parent, and before it has an independent existence of its own. In various species differences are found to exist in the place where the germ is attached to its parent; and also, in the occasional cause which detaches it, and gives it a separate existence; but, it is a rule which holds universally, without one single exception, that the progeny must have originally formed part of a being like itself. The separation of the germ is termed *generation*. Many ancient, and some more recent philosophers, believed that certain organized beings could be produced without parents; and this opinion, though now completely exploded among the learned by the most convincing experiments, still maintains its ground with the ignorant. It originated, as most errors do, from hasty and inaccurate observation. Virgil gravely attempts, in a very elegant passage of the Georgics, to

Explain
The great discovery of the Arcadian swain;
How art creates, and can at will restore
Swarms from the slaughter'd bull's corrupted gore.

And Kircher, who lived in the seventeenth century, gives a recipe to make snakes; which, however, he does not appear to have tried. In Scotland, the country people still believe that the hair-worm (*Gordius aquaticus, L.*) can be formed artificially by placing a horse's hair in water; and this unfounded opinion is, we understand, generally diffused throughout the kingdom. The mites in cheese, the blight on plants, and the maggots in meat, seem at first sight to favour the belief in spontaneous generation; but in all these cases the insects have been demonstrated to proceed from eggs, deposited instinctively by the parent, upon a substance capable of affording nutriment to her young. The popular mistakes on this subject are generally, however, concerning the lower tribes of animals. But the ancients taught that even man could be produced without a parent. The newly-formed earth was supposed to have been originally covered with a green down, like that on young birds; and, soon afterwards, men, like mushrooms, rose from the ground. Lucretius (A. C. 60) relates, that even in his time, when the earth was supposed to be too old for generation, "many animals were concreted out of mud by showers and sunshine."

The time when the phenomena of reproduction first exhibit themselves in animals is termed *puberty*. Then the reproductive organs, which previously were but slightly apparent, acquire a remarkable development, and in some species obtain certain external characters which remain during the whole course of their lives. *Infancy* is the period comprised between birth and puberty. It is during the time preceding puberty that the growth of the body chiefly takes place, although it may continue for some time afterwards. The length of the period of infancy bears to that of life a certain relation, which may be regarded as almost constant. Buffon remarks, that in our climates, for the largest animals, it is about the one-seventh part of their entire life. At the age of puberty, the mammalia assume the characters of maturity. Their height attains its greatest limit, and the distinctive marks of each animal become bold and well-defined. The physiognomy assumes a more animated expression; their voice becomes hoarser or stronger, and the fur handsomer; while the vivacity of their movements marks the impetuosity of those passions which animate them at this epoch. The male becomes distinguished from the female by colours which are commonly darker or browner, and in many species by certain definite external characters. Thus, some male apes acquire a beard and a coat of long hair; the lion obtains a mane; and stags and roebucks are armed with branching horns, of which the females are nearly always deprived. He-goats and rams are at once distinguished from the females by their horns, their masculine gait, and combative disposition. This superiority in the males is most marked among the ruminantia, which are commonly polygamous, and where each male having several of the other sex to keep in subjection, it becomes necessary to assign him a physical superiority, unnecessary in the monogamous species, where the sexes are always more equal in strength.

Puberty constantly exhibits itself much sooner in females than in males, although the reproductive power remains longer with the latter than with the former. In our climates man attains this condition at the age of fifteen or sixteen, and woman at that of fourteen or fifteen; in warmer climates it exhibits itself at the age of twelve to fourteen in the former, and at ten to twelve in the latter. With most of the other mammalia, excepting the domestic animals, we are still ignorant of the precise periods when puberty commences. Dogs are capable of reproducing at the age of nine or ten months; cats from a year to eighteen months. A lioness of the menagerie at Paris was six years old when she exhibited these phenomena for the first time. Rabbits can procreate at the age of five or six months; hares a little later; and guinea-pigs at five or six weeks. Sheep show signs of puberty when one year old; rams, he-goats, and stags, at eighteen months. Horses produce at two years and a half, and mares a little sooner. Camels, according to the ancients, at three years; wolves at two years; cows at eighteen months; bulls six months later; the she-ass from eighteen to twenty months; and the ass at two years. It is, however, the interest of the grazier to prevent the domestic animals from procreating before they have attained their full growth, otherwise the deterioration of the races is sure to follow.

There are certain seasons of the year when most mammalia become susceptible of the instincts of reproduction. This is termed the *rutting* season, during which the usual character of the animals is totally changed, especially of the males. The most timid animals, being excited by the abundance of food and the internal suggestions of instinct, acquire a degree of courage and even fury, which urges them on in a career of madness, which can be compared only to the habitual ferocity of the most formidable species. The females also, at this period, lay aside their habitual reserve, and are seen to provoke the males by biting, teasing, and following them everywhere.

Some mammalia in our countries, as well as in those of the south, whether males or females, remain always in a state adapted for procreation, after having once attained the age of puberty. With the exception of the monkeys, this happens only to those species, which either receive an abundant nourishment from man, or else obtain a plentiful supply by plundering his stores. Of the first kind are the dog, cat, rabbit, guinea-pig, hog, bull, buffalo, horse, and ass; in the second division must be placed the common rat, the common mouse, the wood-mouse, the economic mouse, and the hamster. With the animals of the menagerie, the change of climate which they experience, and the constraints of confinement, occasion them to undergo certain deviations from their natural period of rutting. Among these may particularly be enumerated, the lion and other cats from warm climates, the Cape ichneumon (*Manguata grisea*,), and the Cape genet (*Paradoxurus typus*,) the ichneumon of Egypt, the gnu antelope, and the zebra; also the axis deer from the banks of the Ganges, and the kangaroo of New Holland. It commonly happens, however, with the mammalia, when they have not been modified by domestication or confinement, that each has a peculiar season when the phenomena of the rut more especially present themselves. Thus, winter is the rutting time of the wild cat and martens of Europe; of the wolf, from December to February; of the jackal and corsac fox (*Canis Corsac*), only in winter. The Arctic fox (*Canis lagopus*) is in season at the end of February; the bear, in summer; the hedgehog, at the end of winter; and the hare in February or March. The beavers seek the females in the beginning of January; the American ondatra and the common squirrel, in spring. The dromedaries seem to be more in season about the month of January than at any other time. Camels begin about the middle of November, and end at the commencement of February. The month of September is the chief time for the sheep and goats, although the males of both species are always fit for procreation. In the stags of our countries, the roebuck, and other deer, the rutting season succeeds to the period when the horns are renewed, that is in November, and after this time the horns fall. The rein-deer are in the same case. Thus the season of the rut varies with the species; but it is always so arranged in reference to the term of gestation, that the young may make their appearance at a favourable season of the year, when the heat of summer will serve to aid their growth, and assist in developing their forces. At this season, also, a luxurious vegetation supplies the herbivorous animals with abundance of food, which favours the secretion of milk, and insures its continued supply.

The external signs of the rutting period vary greatly with the several species. In those which are capable of procreating at all seasons, such as man, the monkeys, dogs, cats, and horses, no particular sign is observed. It is different with the rodentia. We find, likewise, that all those odoriferous mammalia, which are supplied with pouches from whence the odours emanate, emit their perfumes at this time with unusual force. In the greater number of animals belonging to the deer genus, and in several antelopes, the larynx or windpipe of the male projects considerably; and it cannot be doubted that the change of tone which his voice undergoes is owing to this cause. It usually happens that the females exhibit the external signs of the rutting season in a milder and more subdued form than the males. Among the mammalia, and indeed in all living beings, the period of puberty and reproduction is one of energy and strength; all their affections become more ardent, and their wants irresistible. The term *rut*, from *ruere*, to rush headlong, serves to express the fury which transports these lower animals. Alike ferocious and untameable, they are susceptible at this period neither of fear nor any other passion, and seem deaf even to the calls of hunger or sleep. The bull forsakes the meadows, and rambles everywhere in search of his mate. The forests resound with the howling of contesting wolves, and the lion, with a deafening roar, defies his rivals to the combat. We may easily perceive the final cause of these contests among the lower animals during the rutting season. Nature ever sacrifices the interests of individuals towards the perfection of species. The most vigorous males always possess the most formidable weapons of attack and defence, while the more effeminate individuals exhibit their feebleness at once in their horns and their want of courage. It is especially among the polygamous races where these combats of the rutting season are more conspicuously observable, because each male fights for several females. In the monagamous species, on the contrary, where the numbers of the sexes are nearly equal, these battles seldom occur. Again, in the carnivora, when the number of the males surpasses that of the females, duels become both frequent and sanguinary. The seals are perhaps more polygamous than any other of the mammalia. Each maintains a kind of seraglio or family, composed, perhaps, of one hundred and twenty females, which he defends from the approach of any other male, with the utmost jealousy and rage. Other species, less faithful or more complaisant, pass from conquest to conquest, and pay their court to all the beauties of the neighbourhood.

The duration of this season varies with different species; but, in general, among the wild animals it ceases as soon as the females have been fecundated. With most of the latter, the external signs of the rut immediately disappear; the females resume their usual reserve, and repel with rudeness the approaches of the male. There are exceptions, in the monkeys, the mare, and in our own species. The female rabbit is likewise an exception, though only an apparent one; as from the peculiar formation of the matrix, she is susceptible of a twofold impregnation, or superfetation. In some species of domesticated animals, especially in the dog, copulation is maintained for a long time after the emission of the fecundating fluid; whilst among the greater part of the birds, especially in the gallinæ, the union is instantaneously dissolved. It is always dangerous in the former cases to force a separation, which is sometimes attempted, although opposed by the peculiar organization of the sexual organs; the intention of Nature apparently being, by this extraordinary prolongation of the union, to render conception more certain. The older females of each species exhibit an attachment for the males, at an earlier season of the year than those of a less advanced age. After conception, as has already been observed, the females, in general, repel the approaches of the male. In all cases where the races are peculiarly ferocious, as in the lion, tiger, panther, and other large cats, the females are the first to solicit the approaches of the male. Had this not been the case, it is difficult to conceive in what manner their races could have been continued. In species of a milder disposition, the males endeavour to please the other sex, and often exhibit a strongly-marked feeling of jealousy towards their own. The monkeys remain attached to one or two females, rarely to more. Their union seems to be a kind of marriage; they require fidelity, are exceedingly jealous, and severely punish their female companions, who are well-disposed to coquetry, on finding them in company with other males.

The phenomena of generation must, however, be considered in another point of view, at once singular and surprising. It seems now beyond a doubt, that the power enjoyed by male animals of continuing their species depends upon the presence in the spermatic fluid of a certain kind of animalcules, which have thence received the name of *zoospermata.* The testicle, or secreting organ, is well known to be the means by which the ovaria are fecundated; and it is remarkable, that within this organ alone zoospermata have been hitherto observed. All animals, before arriving at the age of puberty, are incapable of reproduction, and they are accordingly wholly destitute of zoospermata. M. Dumas informs us that he has made a considerable number of experiments upon young animals, and that he found all of them to be destitute of zoospermata. He particularizes the young of the rabbit, calves, foals, young asses, Guinea-pigs only a few months old, mice of the same age, a great number of Norwegian rats, with pullets, young ducks, and even frogs. The fluid extracted from their organs contained the same kind of irregular globules which are found in the testicles of the mule; but it was wholly deprived of moving bodies, and nothing was found which could in any way approach to the peculiar form of those animalcules proper to fertile animals. It is well known that animals become sterile at a certain period of life, varying with the species. To ascertain whether the presence of these animalcules is essential to fecundity, it becomes necessary to investigate whether very old animals possess them or not. This, to a certain extent, has been done. M. Dumas examined a stallion aged twenty-five years, and which had been incapacitated through age for about four or five years, as well as some dogs of a very advanced period of life. Their sexual organs were perfectly healthy, yet he found them to be destitute of animalcules, and the fluid within them resembled in every respect that of the young individuals already mentioned. It is certain that all male animals hitherto examined, possess spermatic animalcules when in a state of puberty. Young individuals, as well as those that are aged, exhibit no traces of them, and even it is remarked, that birds are destitute of spermatic animalcules, except at those particular periods of the year which Nature has fixed for their procreation. The domestic cock and pigeon, being fertile all the year round, are, of course, exceptions. These spermatic animalcules exist within the testicle in a state of complete perfection; they are transmitted to the deferential canals, without undergoing any alteration during the transition. Neither their motion nor their form is influenced by the mixture of fluids from the other glands, so that, on being emitted, they appear in the same state as when in the spermatic vessels themselves. The spontaneous movement of the animalcules is intimately connected with the physiological state of the individual which supplies them. Each species possesses a species of animalcule, of a form peculiar to itself, and no two species hitherto examined have the same kind of animalcules, although they always remain the same in the same species. The electric spark kills them, but they are not affected by the galvanic current, even when used in a degree of intensity sufficient to decompose water and the salts which it contains.

With the exception of a few solitary instances of superfetation, it is always found among the mammalia, that the fecundation of the male refers only to one birth, being that which next immediately follows the union of the sexes. On the contrary, with the birds, a single union may influence several successive broods. Thus, the domestic fowl will produce fertile eggs at tolerably remote periods of time, after having once received the influence of the male. A young and vigorous cock is adequate for fifteen fowls, and serves to fecundate all the eggs they may produce during twenty days. Hence one male may be sufficient to give existence in a single day to three hundred chickens.

In general, it would appear that the fecundity of animals is greater in proportion as they are more liable to perish from external causes. Insects, plants, and the smaller species of mammalia, which cannot escape from danger, are exceedingly fertile, because Nature diminishes the chances of death by those of life, so that the species may exist continuously. The number of young at a birth thus serves as an index to the probable perils of each species, as well as the voracity of its enemies.

It may be remarked, that although the herbivorous animals produce, in general, only one or two young ones at a birth, this limited power of production is compensated by the greater number of females which the males are capable of fecundating; thus, a single bull or ram is sufficient for a flock of twenty cows or ewes. But the carnivorous animals, being chiefly confined to one female, produce a more numerous race. It thus results in animals, as well as in man, that fruitfulness is the common attendant of monogamy and chastity.

Animals of different species are destitute of the power of producing fertile races. Not only are the individuals themselves naturally averse to unite, but there is found a great variety in the forms of their organs of generation, and in their different periods of gestation, while the hybrid produce, or mule, is, in general, unfruitful. These adulterous unions can hence only take place between animals which are very nearly allied to each other, as between the horse and ass, the buffalo and cow, the bison and zebu, the camel and dromedary, all the combinations in pairs among the wolf, fox, jackal, and dog; between the ram and goat, the hare and the rabbit. These animals are capable of mutually fecundating each other, whenever man can succeed in overcoming their natural antipathy. But there are certain disparities of organization, which wholly prevent the dog from uniting with the cat, the bull with the mare, the ass with the cow, although some examples of the last kind of union have been imagined. See articles Gestation, Nutrition. —*Cuvier.*

GENIP-TREE,—botanically *Genipa.* A genus of tender, evergreen fruit-trees and fruit-shrubs of the madder tribe. Five species, varying in natural height from 10 to 35 feet, have been introduced to our collections from China, Cayenne, and tropical America; and one of these, *Genipa esculenta,* called by Sprengel *Gardenia esculenta,* is a plant of great beauty, and at the same time requires but ordinary greenhouse heat.

GENISTA. See Broom.

GENTIAN,—botanically *Gentiana.* A large genus of very beautiful herbaceous plants, constituting the type of the natural order Gentianeæ. This order is somewhat allied to the dog's-bane order, but may, on the whole, be regarded as intermediate between the figwort order and the polemonium order. It is naturally distributed, principally in pools and on mountains, throughout most parts of the world: and, viewed in the aggregate, is singularly rich and captivating in the form and colour of its flowers. Most of its species are small herbaceous plants; and a very large proportion have flowers of deep cerulean blue, while very many of the remainder have flowers of some shade of orange colour. The roots of most have some degree of tonic and febrifugal properties; and those of several of the generic gentians are very eminent and valuable for these properties. But a grievous drawback upon the high attractions of this order, is that comparatively few of the species will readily submit, or even submit at all, to be cultivated. The species of Gentianeæ within the wilds and gardens of Great Britain comprise about 100 hardy herbaceous species, nearly 40 greenhouse species, and about 20 hothouse species; and these are distributed into upwards of 20 genera.

The genus Gentiana is pre-eminent in its order for at once numerousness, beauty, and utility. About sixty species, either indigenous or exotic, exist in Great Britain; and at least fifty others are known to botanists. All those in Britain are hardy and herbaceous; most are perennial-rooted, a few are evergreen creepers, and about ten are annuals; and while all are handsome, some are elegant or absolutely dazzling. The flowers are very large as compared to the body of the plants, and have an exquisitely outlined campanulate shape; and those of the majority display the most brilliant azure, while the rest, whatever be their colours, are purely and attractively tinted. The amarella, the field, the red, and the purple species, *G. amarella, campestris, rubra,* and *purpurea,* and particularly the yellow species, *G. lutea,* are specially distinguished for the bitter medicinal principles of their roots.

The yellow gentian, *G. lutea,* grows wild on the lofty mountains of Switzerland, Austria, Italy, Spain, and North America, and was introduced to Britain toward the close of the 16th century. Its root is cylindrical, thick, and long; its stem attains a height of about 4 feet; its root-leaves are petiolate, large, stiff, lanceolate, and yellowish green; its stem-leaves are sessile, smooth, concave, and ovate; and its flowers grow in whorls at the upper joints, appear in June and July, and are large, yellow, and handsome. The roots are imported in a dried state from Germany, and are very extensively used in British medicine. A bitter extractive from them in ether or alcohol, or even to a considerable degree in water, contains all their medicinal properties, and has been found by analysis to consist of an odorous but very fugitive principle, a peculiar yellow bitter called gentianine, a free organic acid, a greenish oily matter, saccharine matter, mucilaginous matter, a tawny colouring matter, woody fibre, and a substance resembling bird's lime. But officinal preparations are ordered by the pharmacopœias, in the form, not only of extract, but also of wine, tincture, and infusion. Gentian-root acquired the fame of a stomachic, as well as obtained its name, in the days of an ancient king of Illyria, called Gentius; and it continues to maintain its celebrity, as well as its name, unimpaired. It is given to the human subject in all cases of debility in which tonics are esteemed serviceable, and in cases of dyspepsia, hysteria, jaundice, gout, diarrhœa, dropsy, and chlorosis; it is sometimes combined with Peruvian bark in intermittent fevers; and it acts as an antiseptic on dead animal matter, and has been thought useful in infusions as a wash for putrid ulcers. It is quite as serviceable, likewise, in veterinary practice as in that of human pharmacy; and is very effectively employed in all the corresponding or analogous cases. Clater pronounces it "the very best of the vegetable tonics, and almost the only tonic that should be admitted into cattle practice;" and White, in reference to its suitableness for the horse, declares it "a strong and very pure bitter, well calculated to remove weakness of the stomach and indigestion," and adds that "it generally requires to be joined with stimulants," and that "it is the basis of that famous horse-powder termed diapente." See the article Diapente. Youatt highly recommends gentian for the horse in a manner strictly parallel to the use of it for man.

The spring gentian, *G. verna*, is both the best known and one of the most beautiful of all the species, and seems to be regarded by many an admiring villa-florist and cottage-florist as the only gentian in existence. The normal plant grows wild in some of the barren mountains of England, and has been so multiplied in gardens as to form many a most exquisite edging to the flower border, and opens its large dazzlingly azure flower in April as one of the most gorgeous floral glories of our spring. Its root is slender, branched, and creeping; its leaves are acutely-ovate, half-an-inch long, crowded, and of evergreen habit; its stem is angular, and only two or three inches high; and its flower stands up in solitary magnificence upon the stem, and is more tubular and less campanulate than that of most of the other gentians, and has a bold, wide, open mouth, dividing into five rather pointed parts, which have almost the appearance of separate petals. This plant is somewhat shy of cultivation, yet perfectly hardy in habit; and when grown as an edging, it must be allowed half the breadth of an ordinary grass verge, on account of the largeness of its features as compared with those of box,—and will not flower freely till it has stood two or three years.—An exceedingly handsome white-flowered variety, *G. v. flore albo*, appeared a number of years ago at the Handsworth Nursery, in the vicinity of Birmingham; and now presents to florists the twofold recommendation of being somewhat rare, and eminently ornamental.

The marsh gentian or wind-flower or Calathian violet, *G. pneumonanthe*, grows wild on moist turfy heaths in some parts of England. Its root is long and consists of tapering fibres; its stem usually rises to the height of 6 or 7 inches; its leaves are sessile, obtusely-linear, and about an inch in length; and its flowers are axillary and terminal, large, bell-shaped, with five segmented limb, and of a deep and brilliant blue colour, and bloom in August and September. Two varieties of it, in addition to the normal plant, now occur in gardens,—the spotted, *G. p. guttata*, and the white-flowered, *G. p. flore albo*.

The stemless gentian, *G. acaulis*, is doubtfully indigenous, yet seems to grow wild in some situations in Wales. Its root is fleshy and creeping or branching; its stems are so very short as to give occasion to the epithet stemless; its leaves grow in a kind of tuft; and its flower is solitary, 1½ or 2 inches long, richly azure in the limb, and of a paler blue dotted with black in the tube, and blooms from March till May. This plant completely disputes pre-eminence of beauty with the vernal gentian. A narrow-leaved variety of it, *G. a. angustifolia*, was introduced about 27 years ago from Continental Europe.

The snowy or small alpine gentian, *G. nivalis*, is an annual-rooted native of some of the loftiest mountains of the Scottish Highlands. Its root is simple and slender; its stem is erect, somewhat branched, and three or four inches high; its flowers are produced in so many as 10 or 12 on each plant, and have a brilliantly blue limb, with inversely cordate segments, and bloom in the early part of autumn.

The field gentian, *G. campestris*, is an annual-rooted native of sheep-walks and hill-pastures in various parts of both England and Scotland; and is found also on grass-lands, with gravelly or chalky soils, in the vicinity of the coast. It is sometimes called blue gentian, and sometimes yellow centuary. Its roots are exceedingly bitter; its leaves are paler than those of some other gentians; and its flowers have a palish purple colour, and bloom in August.—The amarella gentian, *G. amarella*, is an annual-rooted native of chalky pastures in England. Its root is yellowish, twisted, tapering, and exceedingly bitter; its leaves are dark green and chiefly acute; its stem is quadrangular, about 6 or 8 inches high, and armed in such a manner with branches and foliage as to have a panicled appearance; and its flowers are erect, and have a white tube and a purplish blue limb, and bloom in August.—Some of the most handsome of the exotic species which may be seen in Britain are *G. umbellata, altaica, angulosa, utriculosa, humilis, clavata, cruciata, saponaria, purpurea, pannonica, asclepiadea, ciliata, triflora, gelida, and septemfida.*

GENTIANELLA,—botanically *Microcale Filiforme.* A beautiful, indigenous, small, annual-rooted plant, of the gentian order. It is called by the older botanists *Exacum filiforme.* It grows wild on bogs and salt marshes. Its stem is 3 or 4 inches high; its foliage is exceedingly bitter; and its flowers are yellow, and appear in June and July.—The name gentianella is sometimes given also to one or more of the short-stemmed blue-flowered, exotic gentians.

GENTLES. The larvæ of flesh-flies or of other dipterous insects, used in angling.

GENUS. A group of species of plants or animals closely resembling one another in some obvious characteristics of form or structure, and at the same time differing in some equally obvious characteristics from other species of the same order. A genus bears the same relation to a species which a species bears to an individual; yet it may not be so well defined, or may be far less natural, and may in consequence depend, in a considerable degree, on the experience or even the prejudices of scientific men for the defining of its limits. Great confusion and inconvenience have arisen from differences of opinion as to the proper limits of multitudes of genera, and from the enormous bulkiness of some and the excessive breaking-up and subdividing of others. Yet the great majority of genera, in our existing systems of natural history, are admirably definite, and appear even to novices as perfectly distinct groups.

GEODORUM. A genus of exceedingly beautiful, tropical, evergreen herbaceous plants, of the orchis order. Three species, the citron, the dilated, and the purple, all about a foot high, and with a predominance of respectively yellow, pink, and purple in the colour of their flowers, were introduced to Britain about 46 years ago from India; and another species, with a labellum of an appearance as if painted with a variegation of colours, was introduced in 1832. The name geodorum signifies "earth-gift," and alludes to the prostrate habit of the flowers, as if gifting themselves to the earth.

GEOFF, or GOFFE. A mow of hay or corn.

GEOFFROYA. A genus of evergreen, tropical trees, of the cæsalpinia division of the leguminous order. It constitutes the type of a tribe or subdivision of the cæsalpinieæ, comprising six genera. The genus geoffroya is sometimes popularly called the bastard cabbage-tree or simply the cabbage-tree, though the latter name confounds it with the palmaceous genus areca. Two species introduced to Britain, and formerly regarded as belonging to it, are now assigned to the genus andira; two species still belonging to it, have been introduced; and a number of other species are known.

The unarmed geoffroya, *G. inermis*, now called *Andira inermis*, contributes its bark to the materia medica of our British pharmacopœias. It grows wild in the low savannahs of the West Indies, and was introduced about 70 or 80 years ago to the hothouses of Britain. Its stem naturally attains a height of about 25 feet, and branches toward the top; its leaves are pinnate, —consisting of 4 or 5 pairs of smooth, lanceolate leaflets, and a terminating odd one; its flowers have a pale rose colour, and grow in clusters on large branched spikes; and its fruit is a longitudinally-furrowed small plum, with a hard seed. The bark, as imported by British druggists, is externally grey and internally black and furrowed; it has a sweetish, mucilaginous, disagreeable taste, and it is pulverizable into a powder similar to that of jalap. It is a powerful anthelmintic, and is particularly eminent in expelling lumbrici. But either when given in overdose, or when accompanied in operation by the use of cold water, it excites vomiting, fever, and delirium; and on this account, it ought never to be touched by empirics, and has been somewhat seldom used by regular physicians, and scarcely, if at all, by veterinarians.

GEOLOGY. The doctrine or science of the structure of the earth, or terraqueous globe, and of the substances which compose it; or the science of the compound minerals or aggregate substances which compose the earth, the relations which the several constituent masses bear to each other, their formation, structure, position, and direction.

To those persons who have never thought upon this subject, the irregular yet graceful aspect of the earth, would seem to awaken no further idea, than that it was a mass of rocks, and clays, and sands, without order and design. Those who have been to the sea-shore, where the rocks have been worn down to mural escarpments, will have perceived the beach to be covered with shingles, or pebbles triturated against each other, and thus divested of the angular form which they possessed when first broken off from the original mass, when they were, as geologists technically say, *in situ*, or *in place.* Every one has found similar rounded pebbles on the dry land, far above the level of the sea. In many instances, they are thus found thousands of feet above the marine level. Ingenious minds will inquire what circumstances could have fractured rocks, rounded their fragments, and distributed them into such dissimilar situations. This is one of the first and most important lessons in geology; and the solution of the inquiry will be found to be the key to similar phenomena, in situations still more extraordinary, where the lower puddingstones and breccias present themselves. To trace these rounded pebbles to their native rocks—for, on the dry land, they frequently exist at immense distances from their beds—it will be necessary to have some slight knowledge of minerals.

Rocks are very nearly related,—nineteen twentieths of the mineral parts of the earth being composed of five substances:—silex, the constituent of flint and sand; alumina, the constituent of clay; lime, the constituent of chalk, gypsum, and all calcareous beds; magnesia, and iron. There are other mineral substances found in the solid parts of the earth, but they are usually in *veins*, and are more especial objects of attention to the mineralogist. Felspar, mica, hornblende, &c., besides being found in veins, are found in the unstratified rocks; and some knowledge of them is essential to the student.

The next question he asks himself is, whether the whole substance of the planet is one solid mass of rocks and strata, resembling those he finds near the surface. The existence of volcanic action, through every part of the known world, either by the eruptions of active volcanoes, or by earthquakes, is an assurance that there must be vast cavities in the globe, where igneous action is fiercely at work, and of which these volcanoes are the safety-valves. Of the extent of these cavities, and of the depth at which they are seated, some opinion can be formed, from the great distances at which particular earthquakes have been felt. That of Lisbon, in 1755, not only affected the lakes and springs in every part of Europe, but was sensibly felt in North America. That of New Madrid, in 1811, shook the valley of the Mississippi, for several hundred miles. Such disturbances are to be considered as the effect of the resistance, which the solid parts of the earth oppose to the expansive power striving in those profound cavities. We then refer to this force many phenomena of the science, and at length comprehend what otherwise would be incomprehensible. For instance, when we are told that the crust of the earth is composed of a series of rocky beds, from the inferior granite up to the uppermost tertiary bed, lying above the chalk; and all, being more than a hundred in number, differing from each other, in many particulars, both as to the relative proportion of the simple minerals of which they are composed, and the organic bodies imbedded in them,—we are at first incredulous; for our own examinations show that the tops of the highest mountains, and the beds of the lowest surfaces, are both formed of granite, or gneiss, or slate, the lowest order of rocks we are acquainted with. Another step or two, and our eyes begin to open. When we know that volcanic matter has been, at all times, poured from beneath these inferior rocks; that the volcanic fires of the Cordilleras, and of Auvergne in France, have equally come through the granite; above all, when we find those superior beds of the series, which lie above the granite, reposing, at high inclinations, upon the flanks of those granite mountains,—the whole truth flashes upon us, and we clearly understand, that these mountains have once existed at lower levels, and that they have been forced up through the superincumbent formations, by the expansive power for ever struggling in the interior of the globe. It is thus we become acquainted with the existence of a power capable of the mightiest mechanical exertions. If earthquakes, in our own time, rend the earth, dislocate its solid parts, and engulph portions of it in the chasms they create, it may have been so at a period coëval with the existence of the planet. If the volcano of Skapta Jokul, in Iceland, could, in 1783, pour out streams of lava sufficiently hot and extensive, not only to melt down the ancient lavas, but to more than fill the gorge of a river two hundred feet wide and six hundred feet deep, damming up the streams, and inundating the whole country, the same may have taken place in ancient times. If, in 1822, the coast of Chile was raised five feet, for the distance of one hundred miles, by a single volcanic paroxysm, we can conceive of continents and mountain chains being raised to their present elevation, by repeated shocks, in ancient times. Finally, if, at the present day, springs, peculiar to volcanic countries, deposit silex, bitumen, lime and other substances, so it may always have been. These probabilities are strengthened by the disturbed state of the transition rocks, the extent of the trap formations, the elevation of Italy, the Alps, and many other regions, and the ancient beds of quartz, pitchstone, primitive limestone and oolites, which approach so near to the modern Travertinos of Italy. Wherever volcanic waters are, there we find calcareous and other mineral substances, and under circumstances warranting the opinion, that they have, at all times, derived their origin from the central and unsearchable parts of the globe. When we look, too, at the great extent of the calcareous formations, especially the transition and carboniferous limestones, found in almost every part of the globe, analogous in geological position, in mineral composition, in organic accompaniments; we can, at any rate, conceive of a source from whence they may have been derived, and which was in operation upon a mightier scale, in ancient periods, than at this day. And from what other quarter, it may be asked, could they be derived? When we see the gneiss uniformly, in the most distant parts of the earth, superimposed upon the granite, the calcareous beds always lying above the gneiss, and the other rocks of the series invariably following each other in an order as regular as that of the letters of the alphabet; we cannot but think of this constancy of succession, as the result of the law of the structure of the planet; as being part of a great design, appropriate to the development of a great end. It is in vain we are told that, if we will allow time, causes now in action will appear powerful enough to have brought the structure of the earth to the condition it is now in. That mountains may be worn down by the continued action of external causes, and that deltas may be formed of their ruins, is conceded; but, we would ask, How did all those calcareous masses, so worn down, and whose ruins are supposed to exist in the extensive floors we have alluded to—how did they first come into existence? It appears easier to believe, that the immense calcareous floors have been quietly and horizontally deposited from central flows, than that they were thrown up into the form of mountains, to be afterwards placed where we find them, by aqueous degradations. Time, it is true, is a cheap commodity with geologists; but, if we are to take, as a measure of the time necessary for the production of all the strata in the geological series, the insignificant progress deltas have made during the last six thousand years, by causes now in action, we shall have to borrow largely from eternity. The theory of Werner supposed the inferior rocks to have been separated from an aqueous mixture by chemical deposition, and that the earth became thus encircled by a stony mass. But, although Werner was a skilful mineralogist, he was but a cabinet geologist. The nature of the inferior rocks is now better known. The intrusive character of the veins of granite, found traversing the granite itself; the passage of all the varieties of the inferior rocks into each other; the connexion between granite and sienite, inferring an identity of origin, and many other circumstances, have produced an entire revolution of opinion, in the minds of most practical geologists.

The existence of marine fossils, at such great elevations above the level of the sea, is another proof of the subterranean birth of continents and mountains. In innumerable instances, we find marine shells converted into stone, without impairing the most delicate spines, and under such circumstances as to assure us, that what is now the tops of mountains was once the bottom of the sea; that here these testacea lived and died, passed tranquilly into the petrified state, and were subsequently raised from the deep. But it is the distribution of the animal, as well as vegetable organizations, through the geological series of rocks, that awakens in us the most profound reflections. Here light first breaks in upon us, in an unequivocal manner, and we begin to consider these various phenomena as showing successive changes from a less perfect to a more perfect state of things. It is well known, that these organized bodies are distributed through an immense number of floors, rising one above the other in the series, from the transition rocks to the highest tertiary. Each of these floors has been, in its time, uppermost in the series, and has been covered by deposits, derived from geological causes, that cannot here be inquired into. If, as our accredited records show, the present surface of the earth has suffered no material change during the last four thousand years, what immense periods of time must have elapsed, during the successive formation of each of the floors, and the existence of the organized bodies which inhabited them! In this amount of time is not included that period belonging to the formation of the rocks inferior to the transition. Those floors may be considered as the pages of the history of nature. It has been remarked, that volcanic waters are strongly impregnated with calcareous matter; and in the present seas where this occurs, we find calcareous rocks forming by the coralline animal. There are few calcareous strata, in which some species or other of these zoöphytes are not present. We often find the transition rocks composed of masses of these simple animals, the inferior species of which have not the gift of locomotion, nor any apparent nervous system. Their organs, which surround a common axis in the simplest manner, appear to infer no higher sense than conservative functions. Animals of the articulated class, to which insects and worms belong, and which rank somewhat higher in zoology on account of their nervous structure and free motions, are rarely met with in the transition rocks. Nor is it surprising; for the lower species, being without a crustaceous covering, could not be expected to take a mineral transmutation, as to form. The trilobite, however, is a characteristic fossil of the transition slates and limestones. The molluscous animals are a higher class of invertebrated animals, with a circulating system and organs of respiration. All animals protected by one or two shells, are of this class. A few species of bivalves are met with in the transition, but the full development of them is found much higher in the secondary rocks; and in the tertiary, or latest geological periods, there are numerous species analogous to those in the modern seas, which is not the case in the older strata, whose inhabitants are all extinct species, with a rare exception or two. These animals appear to have more varied powers, than those simply applied to conservative purposes. They appear to possess the faculty of constructing their testaceous coverings with a view to offence and defence; to make the edges of their shells acute or blunt, as the hard or soft nature of the beds they inhabit, or the nature of their locomotion, may require. The next order of animals is the vertebrated class, or those having internal skeletons, with a receptacle for the brain and marrow. The various gradations by which these rise up to man, inclusive, are found here. We regard that animal as more perfect than another, whose organization admits of the exercise and enjoyment of more various functions. The velocity of the fish enables it to seek its food in different situations, in a much shorter time than the crab or lobster. There are no evidences of vertebrated animals in the lowest transition rocks. Scales of fish are said to have been found in the old red sandstone, which, by English geologists, is counted amongst the secondary. Nor is it until we rise to the carboniferous limestone, that any evidence of Saurian animals is mentioned, and that in a solitary instance. Much higher in the series, we find them in great abundance, especially in the lias, between the deposition of which and the carboniferous limestone, a very long period must have elapsed. Neither is it pretended, that there is any evidence of marine mammalia, or of terrestrial quadrupeds, before the oolitic series; and, even then, the instances are of such a doubtful character, as to rather confirm the doctrine of progressive development, than to weaken it. As we approach the top of the geological series, we find abundance of both marine and terrestrial mammalia. Together with the remains of the pachydermatous animals, we find the bones of the ox and the horse, as if just preceding man, to whom they are so inestimably useful, buried in caves and sedimentary deposits, where the remains of man, or even of any quadrumanous animal, have never been found. In all these things, there seems—to use the language of Sir Humphrey Davy, in his 'Consolations in Travel'—"a gradual approach to the present system of things."—For a further account of the general relations of the earth, and of its surface, we refer to the articles EARTH, MOUNTAINS, SEA, AIR, RIVERS, GLACIERS, ATMOSPHERE, VOLCANOES, &c.

We shall now proceed to some more particular remarks on the component parts of the earth's crust, or covering. This consists chiefly of various kinds of rock and mountain masses, more or less extensive. Rocks may be divided into homogeneous, apparently homogeneous, heterogeneous or compound fragments, loose mountain rocks, and coal-strata. Homogeneous rocks, as quartz, limestone, gypsum, &c., belong to the simple mineral species. In the apparently homogeneous rocks, several species are united in such minute particles, and with so intimate a connexion, that the parts cannot be distinguished by the eye; as in the case of basalt, &c. In the heterogeneous rocks, the component parts are more or less easily distinguished, according to circumstances; as, for example, the quartz, felspar, and mica, in granite. Rocks consisting of confused fragments, as puddingstone, breccia, &c., are made up of variously formed and mingled pieces of stones, held together by means of a uniform paste, like themselves in hardness, but generally of a different composition. Loose stones and fine gravel, sand and loam, are all produced by the mechanical division of large masses, by their decomposition, or disintegration from the action of air, moisture, &c., or from the continued action of streams of water, torrents, &c. A particular place in the mineral kingdom belongs to the species of minerals produced by the destruction of some portion of the vegetable world, constituting the various species of coal. In regard to structure, rocks are crystalline, granular, slaty, compact, porphyritic, and amygdaloidal. The crystalline granular rocks consist of small crystalline or angular parts, fixed together by the process of common crystallization. In slaty rocks, the mass splits into thin plates or layers. Rocks are called *compact*, of which all the particles wear a uniform appearance, and which assume no particular forms. Porphyritic rocks present a compact and homogeneous basis, in which are imbedded other minerals, in the form of insulated crystals or grains. Some rocks contain roundish or irregular cavities, which are either empty, or in part or wholly filled with mineral substances of a different species from the mass enclosing them. These rocks are called *amygdaloidal*. Many rocks contain accidental substances, besides their regular constituent parts; various sorts pass into each other by gradual changes, or there is a change in some of their constituent parts. They also undergo various decompositions from the action of water, air, &c.

Stratification and divisions of Rocks.—In stratification, we find large masses, and even mountains of rocks, divided by parallel clefts, or splits, into large and often very extensive parallel masses or strata. These strata differ, in being more or less distinct, regular or irregular, straight or undulating. They are seldom found to be perfectly horizontal. Some species of rocks are found distinctly stratified; some partially so, and some not at all. Sometimes one stratum rests upon another, and is itself covered by a third. In this case, the second is called the *subjacent*, or inferior, and the third the *superincumbent*, or superior, stratum. The thickness of the strata is very unequal. The extension of strata in a particular line, is termed their *direction*, and is ascertained by means of the compass. Their deviation from a true level, is called their *dip*, and is estimated by degrees of a circle, and according to the four cardinal points—like the direction and dip of the magnetic needle. The portion of the strata above the surface of the earth, is called their *visible end*, or *extremity*. Among the most interesting and important of the phenomena connected with stratification, are the breaks which not unfrequently occur in copper, coal, and other mines, where one rock seems to have slipped by the adjoining one, or to have changed its place, so that the metallic or other vein running through them both, is interrupted, and the continuation of it is thrown higher or lower than the first part. These are technically called *shifts*. Rocks are divided again, according to their more or less regular form,—in which respect they are called *columnar*, *tabular*, *spherical*, &c. By the *position* of rocks is understood their place in the general arrangement of the rocky masses which form the external covering of the earth. The position of rocks is either *conformable*, *unconformable*, or *overlying*. The position of rocks is said to be *conformable*, when the edges of the strata of a rock lying upon another, present the same appearance and arrangement as those of the one upon which it rests. It is *unconformable*, when the rocks which lie upon older formations present a different appearance of strata from the other, they being different in dip or direction. The position is *overlying*, when the strata of the superior rock conceal from the view the position of the rock below. *Alternating position* is when two or more kinds of rocks lie upon each other in repeated succession, and thereby indicate a contemporaneous origin. *Parallel formations* are when different rocks alternately take each the place of the other. The particular situation of minerals, their course and position, which constitute the basis of all mining operations, are of great importance. The *veins* of minerals are the tabular or flat spaces, either in part or entirely filled with different mineral substances, by which masses of rock are intersected, and for the most part in a direction forming a greater or less angle with the direction of the strata of rock. These courses or veins of minerals follow straight lines of direction, or they are bent and curved in various directions and forms. The mineral which fills the vein is more or less different from the rock in which it occurs, according to circumstances, or is, at least distinguishable from it. The direction of the vein is estimated by the angle which it forms with the meridian; its inclination, by its dip, or the angle it forms with the horizon. Some veins have no particular direction or dip, but extend in all directions. The rock upon which the vein lies, is called the *lying*, and the one which covers it, the *hanging*, rock. The vein terminates at its *outgoing* upon the surface of the mountain or earth; the other end tends towards the interior of the earth. The thickness of the vein is estimated by the distance between the underlying and the overhanging rock. A vein is sometimes compressed, or diminishes in thickness; it sometimes stops in the direction of its length; and it is said to be lost, when it splits into several small veins. The vein consists either of one or of several species of minerals; it contains cavities of various form and size, either filled with minerals or having their sides encrusted, or covered by crystals of various kinds, which cavities are called *druses*. The substance of the vein is sometimes firmly united with the rock adjoining it, and is sometimes separated by clay, earth, &c. The relative position of several beds and veins of mineral substances, in any mountain or country, is of great importance in mining. It is seldom that perfect regularity exists among the various mineral deposits in any vicinity; they more commonly vary in their direction, and thus cross and intersect each other. Very extensive deposits of minerals of limited length, are termed *standing beds* or *masses;* and mountain masses intersected by great numbers of small veins and deposits, are called *floors*. *Beds* and *layers* of minerals are particular masses, of a flat or tabular structure, running in the same direction with the strata, but differing from the rocks in which they are contained, in composition and structure, as well as in other circumstances. Foreign deposits, of various kinds, occur in mountains, and in rocky districts of all sorts. Their direction and dip are generally the same with those of the mountain masses containing them. *Mineral deposits* consist either of simple minerals, unmixed, or of rocks. Many deposits contain both. The substances of which the subjects of these remarkable changes consist, are chiefly calcareous, less frequently siliceous, or combustible minerals; also ores. The presence of petrifactions, especially in rocks of new or later formation, is a circumstance of great importance in a geological point of view; since, by a careful consideration of them, it has been ascertained, that successive generations or creations of animal species, such as are not now living anywhere, are found buried in rocks, in such order that similar or related species are found in rocks and situations of a similar character; and that they differ more or less, according to the antiquity of the rock formations in which they occur. And in this manner a ground is afforded for solid conclusions in regard to the antiquity, or period of formation, of many kinds of rocks.

Divisions of Time in the Formation of Mountains, and the Classification of Rocks.—The circumstances of the relative position of rocks, enable us to form some comparisons between them, in regard to their antiquity, although we are unable to state the express period of their respective formations. They are divided, in this respect, into *primitive*, *transition*, *secondary* or *floetz* rocks, *alluvion* and *volcanic* rocks; or, according to a more recent division, into *primary* or *primitive*, *secondary*, *tertiary*, *volcanic*, *diluvial* and *alluvial* deposits—comprehending all rocks and earths. *Primitive rocks* are crystalline in structure, and are remarkable for the great purity and firm adhesion of their component parts. Siliceous and argillaceous earths form the chief ingredients in their composition, and they are remarkable for the absence of all petrifactions to testify the previous existence of organic beings. When both classes occur together, they always lie under the secondary rocks, and are hence supposed to have been formed before them. But although, in their relative situation, the primitive rocks are always lowest, yet, when secondary rocks are absent, the primitive often appear at the surface of the earth, and do, in fact, constitute the summits of the greater part of the highest mountains. When primitive rocks are stratified, the strata are seldom horizontal: on the contrary, they are often highly inclined, and sometimes nearly or quite vertical. But whether these strata were originally inclined, or whether, subsequently to their formation, they were changed from a horizontal to an inclined position, by the action of some powerful cause, is a question on which the most distinguished geologists are divided in opinion. The *transition rocks* bear, also, some resemblance to the primitive; but there is less distinctness of their component parts, and among them we meet the first occurrence of organic remains of animals previously existing.—In the *secondary* or newest formations of rocks, we find many and various remains of a former race of inhabitants of the world. We can trace mechanical operations in the growth of most rocks of this class, and also the fragments of older rocks in the compound structures met with among them. They are earthy and not crystalline, in their structure, and the calcareous earth predominates in their composition. Though sometimes found on the summits of primitive mountains, they are usually placed on the declivities of these mountains, or at their feet, or under the intervening valleys or plains.—Deposits of stones, gravel, sand, clay, earth, &c., are called *diluvial*, when they are so extensive as to cover large portions of the earth, and as to be evidently the results of floods of water, rolling over the whole extent of the earth; *alluvial*, when they are limited in extent, and may be ascribed to the operation of causes now in action, as the sea, rivers, rains, &c.

The classification of rocks is either mineralogical or geological. The former, resting upon the actual composition of rocks, must, of course, take a form and order of arrangement quite different from the latter, in which their relative position and inferred comparative ages form the basis of the system. In the arrangements founded upon elementary composition, or other mineralogical points of similarity, rocks are often found, in near relation and approximation, which belong to periods of formation far remote from each other; and older and more recent formations of rocks often present striking similarities, in composition and other respects, from which their relative ages could not by any means be inferred. In opposition or contradistinction to this, may be regarded the geognostic or geological arrangement of rocks, which attempts to follow the order in which they are supposed to have been formed.

The following is a brief statement of the general grounds of geological opinions and systems. All writers upon this subject agree in this: that there are evident marks of at least three distinct revolutions or changes, which have been coextensive with the surface of the earth, and which occurred previously to the earth's assuming its present form; by which the order of things was wholly changed, and all creatures living at each period entirely destroyed; and which have been followed, in each case, by a new organization of things, partially, but not wholly, similar to the preceding. Various circumstances seem, also, to render it as probable, that man was not a witness of any of these changes, but that it was after the last of them that he was numbered among the inhabitants of the earth;—and it follows of course, from this, that the flood, of which traditions exist in all countries, is not one of those alluded to. As each race of organized beings was successively overwhelmed by that destructive commotion, which was to terminate in the formation of a new covering for the earth, various remains were left, and are still to be recognised, which indicate the form and size of those lost races of animals, and show them, with few exceptions, to have been very different from the races at present in existence. These remains give us distinct accounts of the beings who then inhabited this earth, as we now do; but they, unfortunately, give us no distinct account of the events which terminated in a change so destructive to them. In this respect, they resemble the gigantic architectural and other artificial remains, which are found in Asia and America, and which date from a period, and belong to a race, of which we have no other tidings,—the impossibility of attaining which, only renders their inspection the more interesting. The races of beings which were last destroyed, lie in the upper strata of the earth, while their predecessors are buried far beneath; but each present characteristics sufficient to mark and identify them. The first, or those which are now found at the lowest points in the earth, differ entirely from those which now exist, and show that the relations which were then established among the occupants of the earth were quite different from those now existing. Writers are, also, agreed in this: that, previously to the existence of those races, of whose remains we were just speaking, and which, in point of perfection, were so inferior to the present races of animals, this planet was waste and void, and that it existed in a fluid form, at least those parts now constituting the primitive rocks, and that they became solid by crystallization. The spheroidal form of the earth, which is flattened at the poles, and the phenomena presented by the internal structure of many mountains, afford strong grounds for the belief, that the mass of which they were formed, was in motion when it began to become solid, and that it became so before its parts could entirely assume a new order of arrangement.

Upon the question as to the cause of this fluid state, however, opinions are divided. Some geologists, at the head of whom is Werner—whose hypothesis has already been alluded to, in the general remarks, at the beginning of this article,—are of opinion that the substances composing the primitive rocks were penetrated by and dissolved in water; while others have believed that the earth was, at that period, of a much higher temperature, and that its materials were then melted, or existed at a glowing or red heat. These two have been called the *Neptunian* and *Vulcanian* hypotheses; the last of which has always counted the most numerous adherents. Buffon's conjecture, that the earth was a portion of the sun struck off by a comet, involves a mathematical absurdity, and has found no supporters. La Place advanced the idea, that the sun formerly possessed a much higher temperature than at present; that the gaseous elements, or parts of it, extended beyond the orbits of the planets belonging at present to the solar system; and that, as this gaseous atmosphere became cooler, its particles were attracted by each other, and collected into spherical masses, at different distances from the sun, thus forming the planets, which became solid as they cooled. According to this hypothesis, the earth was once so hot, that it had a gaseous form. Hutton, who has taken great pains to support the Vulcanian hypothesis, supposed that the internal part of the earth was fluid, or melted by heat; that this subterranean fire, as well as the water of the atmosphere, was concerned in all the past revolutions in the earth's composition, and is constantly producing new ones, which succeed each other at long intervals; and that, thus, what is now land was once the bottom of the sea, of which, when exposed, lands and mountains were formed. Werner objected to the Vulcanian hypothesis, that our primitive mountains and rocks often present appearances, which are quite inconsistent with the supposition of a glowing heat or melting temperature,—as the things therein contained could not have existed at such a temperature. Water, for instance, is one of their essential elements. These appearances could not have been presented by a melted mass, which was at once cooled. Hutton, on the other hand, has attempted to answer these objections, by referring to experiments, in which it was found that substances, which were decomposed when subjected to a melting heat, under the common pressure of the atmosphere, would preserve their composition unchanged at the same temperature, if at the same time subjected to a very great pressure. This was found to be the case, for example, with the carbonate of lime, which was found to retain its carbonic acid, when fused under such circumstances. This is not, however, the place to clear up all the difficulties and objections to which both these hypotheses are found to be open. Suffice it to say, that neither appears to be reconcilable with our present knowledge and opinions. The supporters of the one theory often laugh at the other: and while, on the one hand, the organic remains found in the upper strata of the earth seem quite inconsistent with a formation by fire, and very clearly point out a watery medium as their original matrix, so, on the other hand, the disciples of Werner have failed to take notice, that the originally fluid state of the whole globe, previous to the existence of living creatures, and to these revolutions in the state and structure of the earth, is unaccounted for by their theory. It is, for instance, wholly at variance with our present knowledge of the solvent powers of water, to suppose that the elements of granite rock were ever dissolved in it. And to suppose that, some thousands of years since, water had other powers of solution, is an absurdity; for, as the essence of all bodies lies in their properties, it would be equivalent to saying that water was not then water, or that the constituent parts of mountains were not then the same as now. It is only obscuring a dark subject, and not explaining it. But, if we suppose the elements of the earth as existing, and as brought in contact, but not combined, when this combination took place, the usual attendant of such phenomena, fire, would be exhibited in its most intense form. The result of the combination would be, a spherical fluid mass—a drop, so to say, of immense magnitude, of very high temperature, which cools slowly by radiation, and thus affords an opportunity to the melted elements of matter to assume a more or less crystalline form while cooling. But who is competent to form opinions upon the original mode of the earth's formation? Human understanding has its limits, and within these should it find its occupation. But we may be permitted to say, that, considering them merely as theories, the Vulcanian certainly involves the fewest inconsistencies, with the present state of our knowledge upon these subjects.

See Breislak's work upon geology. One of the most valuable works upon this subject is that of Humboldt upon the relative position of rocks in the two hemispheres. We may also refer to the Transactions of the Geological Society of London, commenced in 1807, and Leonhard's Characteristics of rocks published at Heidelberg, 1823. See, also, Cuvier's *Theory of the Earth*, with notes by Jameson; Lyell's *Principles of Geology;* and Buckland's *Reliquiæ Diluvianæ.*

GEOMETERS, Loopers, or Slender Bodies,—scientifically *Geometridæ*. A tribe of insects of the moth division of lepidoptera. The names geometers and loopers, allude to the peculiar manner in which the caterpillars effect locomotion; and the name slender-bodies alludes to the comparatively attenuated form of the perfect insects. The caterpillars of the species and even of the genera are, in many instances, not easily distinguishable from one another; and yet all are readily distinguishable from those of other tribes. "Six conical pointed feet always exist on the pectoral segments, or anterior part of the body, and one or more pairs on the hinder extremity of the body, the intermediate or abdominal segments being entirely destitute of feet. In consequence of this arrangement, the caterpillar is unable to advance with a proper and continuous reptant motion, and has therefore recourse to another mode of progression. It fixes the body to the plane of position by the hinder feet, and stretches itself forward to the full extent; then, laying hold with the anterior feet, the tail is left free, and drawn towards the head till it comes up to the anterior feet, the intermediate portion of the body being, by this process, bent upwards into a loop or arch. Every progressive movement is effected by a repetition of the same manœuvre; and the space is thus traversed by a series of regular and measured steps, each of which is nearly equal to the length of the insect's body." The perfect insects are distinguished from those of all other tribes of moths by the horizontal position of their wings; and from those of some, by the slowness of their flight and the slenderness of their bodies. One of the most mischievous of the geometers is the subject of our article BUPALUS; and two or three others, of the most remarkable, may here be briefly noticed.

The common V-moth, *Grammatophora vavaria*, is exceedingly mischievous. Its caterpillar has a greenish ground colour, spots of black, and dorsal and lateral lines of yellow. The wings of most of the perfect insects have an ashy grey colour, with powderings and mottlings of darker colours, and a mark somewhat like the letter V; but the wings of some are whitish, marbled with ash colour; and those of others have so dark an ashy ground colour as to resemble the colour of soot. This species infests the gardens of many parts of England, and feeds on the leaves of gooseberry bushes, sometimes to the utter destruction of the foliage; and in some years, the insect is so exceedingly abundant as to devastate the gooseberry plants of entire and extensive districts.

The large emerald moth, *Hipparchus papilionarius*, is a somewhat rare insect in Britain, and challenges attention vastly more for its beauty than for its destructiveness. Its caterpillar has a green ground colour, with a yellowish line on the side and red tubercles on the back; and it feeds on the leaves of birches, hazels, alders, and lime-trees. The perfect insect is comparatively very large; its antennæ have a reddish-white colour; and its wings have a fine grassy green colour, and a very elegant outline, and are elevated during the insect's repose, and altogether so resemble those of a butterfly as to have suggested the epithet *papilionarius*.

The swallow-tail moth, *Ourapteryx sambucaria*, occurs in the woods and large gardens of Britain and of most other parts of Europe. Its caterpillar has a cinnamon colour, and is longitudinally furrowed; and though popularly supposed to feed principally on the leaves of the elder-tree, it really feeds on apricot-trees, on other fruit-trees, on the sallow, and often very mischievously, and at the same time unsuspectedly, on plants of the geranium family. The perfect insect appears about the end of June or the beginning of July; and is one of the swiftest of the geometers, and one of the most conspicuous of the moths. Its wings measure from 2 to 3½ inches in expanse, and have a pale yellow colour, sprinkled with greenish-grey, and streaked transversely with dusky yellow; and its hinder wings have, in their hinder angle, two remarkable black spots, and terminate in elongated processes, which resemble those of some of the most conspicuous butterflies, and give rise to the popular epithet "swallow-tail."

The mottled umber moth, *Hibernia defoliaria*, abounds in the woods, coppices, orchards, and gardens of Britain and most other parts of Europe; and is one of the most destructive insects of its tribe. Its caterpillars generally do more or less injury to pear-trees, and other fruit-trees; and, in some years, are so enormously multitudinous, particularly in France, as to perpetrate very serious havoc. The females of the perfect insect have either no wings or very slightly developed ones; and they remain stationary on the twigs and branches of the fruit-trees, and deposit their ovules in prodigious numbers upon the leaves. The colour varies, but generally is yellow dotted with black; and the time of the appearance of the perfect insect is autumn.

The lilac moth or lilac beauty, *Pericallia syringaria*, is of rare occurrence in Britain, yet challenges notice by the singularity of its caterpillar and the elegance of its imago. The colour of the caterpillar is, in most instances, a brownish red, with a black dorsal band on the first four rings; its form is thick, with curious variegations of a horn, tubercles, and excrescences; and its attitude in repose is the extraordinary one of an upward fold of the body in the manner of a curved line, with a little elevation of the head. The upper wings of the perfect insect are grey and yellowish, tinted with rosy purple, dashed on the edge with a blending of purple and white, and elsewhere striped with brown and violet; and the lower wings have a much greater preponderance of grey. This insect takes its specific name from feeding on the lilac or syringa; but it feeds also on the privet and the jasmine.

GEORGINA. See DAHLIA.

GERANIUM. A genus of herbaceous plants, constituting the type of the natural order Geraniaceæ. This order is distinguished from all others by the peculiar structure and organic habits of its capsule. Five cocci or cases, with the same number of thin flat styles round a long conical beak, constitute the fruit; and, at the time of maturity, the styles roll back, and the parts are difficult of separation. The plants of the geranium order resemble those of the mallow order in their stipules, in the arrangement of their petals, in the agglomeration of their stamens, and in some other characters; they so closely resemble those of the tropæolum genus as to be almost, if not altogether, identical; and though differing in most respects from those of the vine order, they present some interesting points of relationship even to them. The young stems of the Geraniaceæ, like those of the Viniferæ, are articulated, and can be separated at the articulations; the lower leaves of both orders are opposite, while the upper ones are alternate; and, though the Geraniaceæ have no tendrils, they produce their peduncles in such a relationship to the leaves as to correspond to the tendrils of the Viniferæ. The Geraniaceæ, viewed collectively, are celebrated for the eminent beauty of their flowers, for the facility with which they hybridize, and for their consequent adaptation to the tastes and prosecutions of both professional and amateur florists. Yet though all are popularly called geraniums, the main floral glory of the order is concentrated in the genus pelargonium. Some of the Geraniaceæ, especially of such as have succulent bark and leaves, are somewhat acidulous; a number are sufficiently resinous to exhale a terebinthine odour, while a few are so much so as to burn like a piece of exceedingly resinous Norway spruce; and most are in some degree astringent, while the root of probably several species, but particularly of *Geranium maculatum* possesses properties so similar to those of gum kino and other recognised astringents of the materia medica as to be a suitable remedy for nephrites, diarrhœa, and cholera. The odour of the Geraniaceæ is strong and peculiar, and ranges, throughout the order, from a disagreeable smell resembling some kinds of animal fetor, to the most piquant and delicious fragrance resembling the mingled perfume and balsam of the richest pastiles. The plants of Geraniaceæ at present in Great Britain, exclusive of many thousands of British hybrids and fugitive varieties, belong to nearly 100 hardy herbaceous species, about 300 greenhouse species, and 3 or 4 stove-house species; and are distributed into the genus Pelargonium and the suborder Geranieæ, the latter comprising the genera Geranium, Sarcocaulon, Erodium, and Monsonia.

The genus geranium comprises 14 British species, about 50 introduced exotic species, a few unintroduced exotic species, and a countless number of hybrids and varieties. Nearly 20 of its species are hardy annuals; 4 or 5 are hardy, perennial-rooted herbs, with one-flowered peduncles; one, *G. multifidum*, is a Cape-of-Good-Hope, evergreen herb, with a one-flowered peduncle; 5 or 6 are greenhouse, perennial-rooted herbs, with two-flowered peduncles; and all, or very nearly all, the remainder are hardy, perennial-rooted herbs, with two-flowered peduncles. Most of the annuals and some of the perennials are mere weeds; but many of the others in their normal state, as well as most of the varieties and the hybrids, possess much floral beauty. The prevailing colours of the flowers are purple, red, pink, and blue; but some other colours, particularly white, pale red, stripedness, and variegation occur. The capsule of the plants, particularly of the best known indigenous species, exhibits some similarity of form to that of the bill of a crane, and has occasioned the genus to figure, both in popular nomenclature and in systematic works, under the name of Crane's-Bill. But florists, when speaking of the plants under their proper name of geranium, ought to accustom themselves to distinguish broadly between them and the vastly more magnificent pelargoniums. See the article PELARGONIUM. We can afford space for a brief special notice of only the most conspicuous of the indigenous species, and one or two of the best known of the exotic species.

The meadow crane's-bill, or blue meadow geranium, or meadow crow-foot-leaved geranium, *G. pratense*, is one of the most beautiful of our perennial-rooted indigens. It grows wild in rich and somewhat moist meadows, pastures, and thickets, in both England and Scotland; and is particularly abundant in the best pastures of hilly districts. A novice who looks for the first time at it in our gardens is delighted with its beauty, and can scarcely believe it to be a wild flower. Many stems rise from each root, and usually attain a height of about 20 inches; its target-shaped leaves garnish the stems, and are divided into 6 or 7 parts at each joint, and are cut into several acute segments in the manner of pinnate leaves, ending in many points; and the flowers are produced on two-flowered peduncles at the top of the stems, and are large and brilliantly blue, with equal petals, and bloom from May till July. A double-flowered variety has been found in the mountains of Scotland; a white-flowered variety and a striped-flowered variety, both very handsome, occur in gardens; a peculiar blue-flowered variety, called the Daurian, was introduced about 30 years ago from Dauria; and many fugitive varieties, with diverse shades of colour, may be obtained by raising plants from seeds matured in our gardens. The several varieties are easily propagated by the parting of their roots in autumn; and they flourish in any kind of garden soil, and require no other culture than to be kept free from weeds.

The bloody geranium, *G. sanguineum*, grows wild on rocky ground in Britain, but has long been cultivated in gardens, and is abundantly worthy of a place in any flower-border. Its root is fibrous yet fleshy and pretty thick, and has a large head; many stems rise from the root, and usually attain a height of about 12 or 15 inches; its leaves are five-lobed, and again subdivided almost to the midrib; and its flowers stand on long hairy one-flowered footstalks proceeding from the side of the stems, and have five broad regular petals and a deep purple or blood colour, and bloom from June till September.—A variety of this species, called the hairiest, *G. s. villosissimum*, was introduced to our gardens from Continental Europe, and has a creeping or trailing habit, so as seldom to rise more than 3 or 4 inches from the ground.

The Lancaster geranium, *G. lancastriense*, has been regarded by some botanists as only a variety of the bloody geranium, and called *G. s. prostratum;* but besides possessing sufficient distinctness of character to constitute it a separate species, it pertinaciously retains all its distinctive properties when raised from seed, and will not make any approach toward the bloody geranium. Its stems are considerably shorter than those of the bloody geranium, and spread flat on the ground; its leaves are much smaller, and not so deeply divided; and its flowers are much smaller, and of a pale colour, marked with purple, so as to have a striped appearance. This species grows wild in Lancashire and Westmoreland.

The knotty geranium, *G. nodosum*, is a perennial-rooted native of some of the mountains of

England, and grows abundantly in some parts of France. Its stems are branching, and usually from 6 to 12 inches high; its leaves garnish the stems, and have each three somewhat broad and undivided lobes, with crenated edges; the leaves on the lower parts of the stem are opposite and stand on pretty long footstalks, and those on the upper parts are single and sessile; and the flowers stand on short footstalks at the end of the stems, and have a dirty purple colour, and bloom from May till October.

The dusky geranium, *G. phæum*, is a perennial-rooted native of mountain thickets in some parts of the north of England, and abounds on many of the Continental Alps. Its stems usually attain a height of from 12 to 20 inches, and branch at the top, each into 3 or 4 divisions, which severally terminate in two or three two-flowered peduncles; its leaves are five or six lobed, and are laciniated on their edges, and those near the root have long footstalks, while those toward the top are sessile; and its flowers have erect petals, and a dusky, dark, blackish colour, and bloom from April till June.

The Robertian geranium, or Herb-Robert, *G. Robertianum*, grows wild on gravelly hedge banks, and on waste stony grounds, in many parts of Great Britain. Its root is annual; its stems usually attain a height of about a foot, and frequently have a reddish colour; its leaves grow in pairs at the joints, and are largely and very much subdivided; its flowers are red, and bloom from April till October; and its capsules are long and slender, and have a considerable similarity of form to cranes' bills. This plant abounds in the medicinally astringent principles which distinguish some other species of its order; and it may be successfully used either fresh in a state of decoction, or dried in a state of powder.

The other indigenous geraniums are the wood species, *G. sylvaticum*, a very beautiful perennial, of 18 or 20 inches in height, carrying blue flowers in May and June, and inhabiting the mountain thickets of Britain; the Pyrenean species, *G. pyrenaicum*, a handsome perennial, of 12 or 15 inches in height, carrying purple flowers from May till August, and inhabiting the meadows and pastures of Britain; the shining species, *G. lucidum*, an annual weed, of about 6 or 8 inches in height, carrying pink-coloured flowers from May till August, and inhabiting the waste stony grounds of Britain; the dove species, *G. columbinum*, an annual weed, about 10 inches high, carrying pink-coloured flowers in June and July, and inhabiting the chalky banks of England; the round-leaved species, *G. rotundifolium*, an annual weed, 3 or 4 inches high, carrying pink-coloured flowers in June and July, and inhabiting the gravelly banks of England; and the cut-leaved or jagged-leaved species, *G. dissectum*, an annual weed, 6 or 7 inches high, carrying purple flowers from May till July, and inhabiting the waste grounds and uncultivated fields of Britain.

The Iberian geranium, *G. ibericum*, is a hardy perennial, and was introduced to Britain about 45 years ago from the Levant. Its stem is about 20 inches high, and slightly branched; its leaves are rounded, and from five to seven lobed; and its flowers are large, purplish-blue, and decidedly elegant, and bloom from June till September.—The channelled geranium, *G. striatum*, is a hardy perennial, and was introduced to Britain from Italy in the former half of the 17th century. Its stem is usually about a foot high; its leaves are rounded, and five-lobed; and its flowers are flesh-coloured, with veiny stripes or lines of a darker colour, and bloom from May till October.—The most beautiful or otherwise interesting of the introduced exotic species are *G. nepalense, umbrosum, maculatum, collinum, sibiricum, macrorhizum, angulatum, eriostemon, longipes, aconitifolium, tuberosum, canescens, incanum*, and *argenteum*,—the three last frame perennials, and all the others hardy perennials.

GERARDIA. A genus of ornamental exotic plants, of the figwort order. One hardy annual, three hardy biennials, two or three hardy perennials, and one tropical perennial, all herbaceous, have been introduced to Britain; and about 20 other species are known. Most of the introduced species are from 12 to 24 inches high; and some have purple, some yellow, and some pink-coloured flowers.

GERM. The embryo of a seed, or the organic rudiment of a bud. Duhamel used the word germs "to signify those latent and rudimentary molecules, which he regarded as being dispersed throughout the whole of the plant, for the purpose of giving origin to buds, whether of root or of branch, wherever buds were wanted, and which he denominated pre-organized germs."

GERMANDER,—botanically *Teucrium*. A very diversified genus of ornamental plants, of the labiate-flowered order. Three species grow wild in Britain; about 50 have been introduced from foreign countries, principally in the southern parts of Europe, and around the Mediterranean; and nearly 40 other species are known to botanists. One group of the species produce their flowers, singly or in pairs, from the axils; another, in whorls, or divided whorls; another, in heads or bunches; another, in spikes or spiked racemes; and another, but small one, in corymbs. Rather more than one half are evergreen undershrubs; two or three are evergreen herbs; three or four are annuals; and most of the others are deciduous or perennial-rooted herbs. About one half are frame plants; three or four require the greenhouse or the stove; and the rest are hardy. We can afford space for a brief special notice of only the three indigenous species.

The common germander, *Teucrium chamædrys*, grows wild on old walls, ruined buildings, stone banks, and waste or neglected grounds, in various parts of England. Its root is perennial and creeping; its stems are hairy, leafy, bushy, erect, and about 9 or 10 inches high; its leaves are entire at the base, tapering, fringed, and of a deep green colour; and its flowers have an intermediate colour between crimson and purple, and are hairy in their tube and their side lobes, and rounded and somewhat concave in their middle lobe, and bloom from May till August. The whole plant is exceedingly bitter, and was formerly held in high esteem as an expectorant, a diuretic, and a diaphoretic; but it has lost the greater portion of its medicinal celebrity.

The wood germander, or wood sage, *Teucrium scorodonia*, grows wild in the woods and thickets of many parts of Britain. Its root is perennial and creeping; its stems are quadrangular, stiff, ligneous, and about 20 inches high; its leaves are petiolate, cordate, serrated, wrinkled, hairy, and deep green, and grow in pairs at the joints of the stems; and its flowers are produced in 3 or 4 long nodding spikes from the upper parts of the stem, and have a pale yellow or herbaceous white colour, with the middle lobe concave and hairy, and bloom in July. The whole plant is glutinous, bitter, and pleasantly aromatic; and was formerly used in medicine; and is employed in Jersey in brewing; and appears to possess some properties closely similar to those of hops.

The water germander, *T. scordium*, grows wild in the marshes of the Isle of Ely and some other fenny districts of England. Its root is small, stringy, fibrous, creeping, and aquatic; its stems are numerous, quadrangular, trailing, and diffused; its leaves are sessile, oblong, hairy, and indented; and its flowers are produced in pairs on each side of every axil of the stem, and sit very close to the bottom of the leaves, and have a pale dull purple colour, with the middle lobe flattish and two-spotted, and bloom in July and August. The whole has an odour like that of garlic; it is reluctantly eaten by cows, and not till they are hungry, and injures the flavour of their milk; it is eaten by sheep and goats, but resolutely disliked by horses; and, like the two other indigenous species, it was formerly used in medicine, but has lost its medicinal reputation.

GERMAN MADWORT. See Asperugo.

GERMEN. A bud, a sprout, an ovary, the organic rudiment of a phenogamous plant, contained in the form of radicle and plumule, within its seed. But though the word is thus diversified and conflicting in meaning, it may be regarded as now, by the general usage of botanists, either an obsolete term, or a synonyme of ovary. See the article Ovary.

GERMINATION. The evolution of a young phenogamous plant from a seed; or, in the language of Keith, "that act or operation of the vital energies of the organs of the seed, by which the embryo is extricated from its envelopes, and converted into a plant." The word germination was formerly used in a correspondingly loose manner to the word germen, and made to mean the evolution of a twig or shoot from the bud of a growing plant, or the process of reproduction from the buds of tubers, layers and cuttings; and it still is occasionally employed to signify every kind of vegetable reproduction, and in particular the reproduction of plants from their organic rudiments, whether the seeds of phenogams or the sporules of cryptogams. But by modern scientific usage, as well as by obvious propriety, it now bears a restricted sense correlative to the word ovary, and therefore designates reproduction only from a cotyledonous organism.

The organic rudiments of cryptogams contain neither cotyledon, radicle, nor plumule, and do not grow uniformly from two constant points of the surface; but are mere homogeneous masses of cellular substance, and send out their increments, whether perpendicularly, vertically, or horizontally, from whatever place is so situated in reference to the contact or action of external agencies as to be stimulated into development. The sporules of ferns are produced on the back of the fronds; those of mosses, in small capsules or urns; and those of lichens and fungi, from tubes within the substance of the plants. But though the sporules of all the more highly organized cryptogams are more or less subject to microscopic observation, and might, by a prodigal act of classification, be brought into the same category as seeds, so as to be described as germinating, those of the more simply organized, and particularly of lichens and fungi, are so exceedingly minute as to escape the most penetrating effort at detection, and so profoundly obscure as to conceal their process of development from the most searching investigation. Millions of millions of sporules are known to arise from a single puff-ball, and many hundreds from the common blue fungus of cheese; and inconceivable numbers—far more than any intelligible arithmetic can express—must annually arise from the plants of every species of lichen and fungus, and float invisibly in the atmosphere, beyond all reach of either microscopic or chemical detection, careering hither and thither upon every current of air, detaching myriads upon every pinion of the slightest breeze, and ready, on every concurrence of favourable circumstances, to attach themselves to their natural niduses, and commence the development of a progeny of plants. Reproduction from these detached and living molecules is now well understood, partly from the analogy of all vegetable existence, partly from the ulterior growth of the minute lichens and fungi themselves, and partly from observation of the most highly organized species of their own orders or of orders closely akin to them; and it is distinctly known to afford not a shadow of countenance to the sneering and frigid doctrine of "equivocal generation," but to display, in common with all the other functionary work of created beings, the presiding care and infinite wisdom of the all-benevolent Creator; yet it cannot, without excessive violence to language and great confusion to thought, be regarded as a process of the same kind as germination. The organic phenomena of the two processes must be widely different; and from the ascertained fact, that growing fungi exhale carbonic acid and inhale oxygen, while growing phenogams exhale oxygen and inhale carbonic acid, the chemical phenomena may not improbably be altogether contrary.

A seed, when placed in the conditions requisite to the development of its organism, sends down its radicle to form a root, sends up its plumule to form a stem, and feeds both with the vegetable albumen stored up, for the purpose, in its cotyledon or cotyledons. In some rare instances, as in those of the bean and the oak, a dicotyledonous seed, artificially deprived of one of its cotyledons, will evolve and nourish its radicle and plumule; and in others, as in that of the gourd, a seed, artificially deprived of its original radicle and plumule, will reproduce these organs, and mature the second set into root and stem. But the plants, in all such cases, are small and delicate, and never attain strength or maturity; and all sound and vigorous plants of even the sturdiest species are produceable only from entire seeds, deposited with their natural envelopes. The albumen of the seed—not true albumen, but popularly called so on account of the supposed analogy of its functions to those of the albumen or white of eggs—is generally enclosed in a toughly membranous or coriaceous or ligneous or bony case; and though it does not require this envelope for any purpose immediately connected with the process of germination, it needs to be preserved by it, up to the time of that process, both from abrasion of its integrity and from external chemical action upon its substance. The proximate principles of which the albumen principally consists, are gum, sugar, and starch; and all these consist of carbon, oxygen, and hydrogen, in nearly similar proportions, and are convertible into one another; but, during the process of germination, all pass into mucilage or hydrated gum; and, in consequence of the sugar and the starch containing more carbon and less oxygen and hydrogen than the gum, oxygen is largely absorbed both to supply the deficiency for gum and to combine with the excess of carbon and carry it off, hydrogen is largely absorbed both to supply the deficiency for gum and to contribute to the reduction of gum to mucilage, and carbonic acid, as the product of the combination of the excess of carbon with oxygen, is plentifully expelled. "By the continued deposition of carbon, very ripe seeds contain more starch or flour than unripe seeds; and from the difficulty of reducing starch again into mucilage, which must take place in the vegetating process before it can be rendered a soluble food for the young embryo, ripe seeds will be found to keep longest, and to survive accidents of bad treatment better than unripe seeds; which, however, from having their food in a state more easily rendered soluble, are found to spring more quickly, and, if sufficiently far advanced, with more vigour, than ripe seeds. In the process of germination, when carried on in the usual manner, if a seed is picked up, the cotyledons will be found filled with a soft mucilaginous substance, generally of a milky colour and sweetish taste. This is the food of the young embryo reduced into a soluble state, and is conveyed through the vessels of the cotyledon to the axis, and thence to the radicle and stem. On the quantity of this food furnished depends the vigour with which the young plant will shoot; and hence, the best means of reducing the albumen of the seed into a soluble food in the speediest manner, and in the greatest quantity, is the greatest desideratum to arrive at in prosecuting enquiries after the best method of furthering the process of germination."

The seeds of annual plants generally retain their vitality for a longer period, and pass more promptly into germination and more rapidly through it, than those of perennial plants. Seeds which contain much oil, such as those of dictamnus, magnolia, myristica, and many others, perish vastly sooner than seeds which are free from oil; and the seeds of the coffee-tree and some other plants will not germinate after being kept more than a few days beyond the time of ripening and gathering. But the seeds of a large proportion of annuals, and those of very many perennials, possess a surprising degree of longevity, and sometimes germinate at such a remote age and in such extraordinary circumstances as to excite great astonishment. Annual plants which have been unknown on a particular field or farm or district of pasture-land for twenty years or upwards, will suddenly make a profuse reappearance after the breaking up of the land by the plough; seeds capable of germinating have, at the time of the pulling down of old buildings, been found embedded in the clay or natural mortar with which the masonry was cemented; seeds of white clover have germinated, in whole crops, as if by magic, in situations where they must have lain buried during hundreds of years; the seeds of forest trees, of species which must have lain locally exterminated during many centuries, or perhaps upwards of a thousand years, often germinate in forest-ground after a speedy clearing of old trees of other species; and some sorts of grain which were found in the Egyptian mummies, and must have lain in them during several thousand years, are said, though not on undoubted authority or with thorough authentication of facts, to have germinated. An account read a few years ago before the Academy of Sciences at Paris states, that, in some recently discovered tombs at Mouzie, the head of a skeleton was placed on a heap of seeds, contained in a cavity left in the cement large enough to hold the back part of it, and that these seeds, on being sown, produced plants of *Heliotropium Europæum*, *Medicago capulina*, and *Centaurea cyanus*. "The seed of *Veronica hederæfolia*," remarks G. Regel, the gardener of the

Berlin Royal Botanic Garden, "is the most remarkable in this respect; for sometimes, after heavy rains, it springs up on the surface of fields where previously no trace of this plant was found, so that it has been supposed that the seed had fallen with the rain. Repeated experiments have, however, shown that these seeds, even in circumstances favourable to their development, have lain for many years without evincing the least change; and we can therefore believe with certainty, that in this case they grew out of the ground. Others, again, infer an immediate creation of many of our common annual plants, and advance many circumstances in proof of it,—such as their sudden appearance in great quantities, or the continual renewal of the growth of weeds in enclosed gardens, which, for a long series of years, have been always carefully destroyed. But all this only demonstrates the long-preserved power of germination retained by many seeds. For even if we cannot disprove the immediate creation of a number of plants of the lowest organization, yet when we reflect how many seeds are disseminated by birds or by animal manure, this hypothesis, which cannot be admitted in the present state of science, is entirely set aside. At Gottingen, I had myself an opportunity of observing, on several occasions, circumstances of this sort. One year, an annual plant, *Alsine sagittalis*, came up in great profusion, which had not been found there for more than twenty years. I also found *Rumex maritimus* and *Cyperus fuscus* thickly overspreading the bottom of a pond that had been drained the year before, no trace of these plants being to be found in the neighbourhood; and what rendered the circumstance the more striking was, that this pond for many years had always been full of water." See the articles SEED, CLOVER, and AGRICULTURAL SEEDS.

The Society for the improvement of Horticulture in Prussia proposes from time to time certain questions, to which it directs the attention of horticulturists. The following was proposed by the Society:—"Is it true that the seeds of the melon and cucumber, being preserved for some years, yield a greater abundance of fruit?" Most observers remark, that the plants obtained from the seeds of the preceding year produce many leaves, but few fruitful flowers, and almost entirely male ones; but that these same seeds, dried by the heat of the sun or of a stove, yield a greater number of fruitful plants, and that it is particularly at the end of some years that they acquire this property. The experiments varied from three to twenty years. M. Schmidt employs seed from five to twelve years old; those of twenty years do not grow. Professor Sprengel of Halle says, he obtained no fruit from seed a year old. M. d'Arenstorff, of Drebleau, obtained fruit, remarkable for flavour and size, from seed of twenty years old. The observations of Professor Treviranus of Berlin afforded the same result. A vigorous vegetation induces in numerous plants, male flowers in the greatest abundance, sometimes even exclusively. This has been proved as far as regards cucumber seeds; but those which are too old produce an opposite result. He had seen seeds of five years old produce only female flowers; they were fecundated by male flowers of another bed, and yielded fruit. M. Voss, head gardener at Sans Souci, sowed on the 17th February 1827, twenty-four seeds of a Spanish melon of the year 1790, being consequently thirty years old, and he obtained eight plants which gave good fruit. This experiment, the most remarkable of all, will excuse our citing eleven others, which he made with seed of a less age, and of different species. Cucumber seeds of seventeen years afforded the same results. M. Voss adds, that some seeds of the *Althæa rosea*, of twenty-three years old, afforded very well-conditioned plants.

We admit, as incontestable, the above-mentioned observations; and have already stated our conviction that many seeds retain for a long time their germinative power. The Rev. Mr. White makes the following observations on this subject:—"The naked part of the Hanger at Selborne is now covered with thistles of various kinds. The seeds of these thistles may have lain probably under the thick shade of the beeches for many years, but could not vegetate till the sun and air were admitted. When old beech trees are cleared away, the naked ground in a year or two becomes covered with strawberry plants, the seeds of which must have lain in the ground for an age at least. One of the *slidders*, or trenches, down the middle of the Hanger, close covered over with lofty beeches, near a century old, is still called strawberry-slidder, though no strawberries have grown there in the memory of man. That sort of fruit did once, no doubt, abound there, and will again, when the obstruction is removed."

Sir Thomas Dick Lauder, Bart., made some curious and interesting experiments in 1817, on the germination of seeds, which we shall describe in his own words:—"A friend of mine possesses an estate in Morayshire, a great part of which lying along the Moray frith, was, at some period not very well ascertained, but certainly not less than sixty years ago, covered with sand, which had been blown from the westward, and overwhelmed the cultivated fields, so that the agriculturist was forced to abandon them altogether. My friend, soon after his purchase of the estate, began the arduous, but judicious, operation of trenching down the land, and bringing to the surface the original black mould. These operations, of improvement were so productive, as to induce the very intelligent and enterprising proprietor to undertake lately a still more laborious task, viz., to trench down the superincumbent sand on a part of the property, where it was no less than eight feet deep. Conceiving this to be a favourable opportunity for trying some experiments relative to the length of time which seeds preserve their power of vegetation, even when immersed in the soil, I procured from my friend a quantity of the mould, taken fresh from under the sand, and carefully avoiding any mixture of the latter. This was instantly put into a jar, which was stopped up close, by means of a piece of bladder tied tightly over its mouth. Having prepared a couple of flower-pot-flats, by drilling small holes in the bottoms of them, so as to admit of the ascent of water, I filled the flats with some of the mould, and placing them in a very wide and shallow tub, made on purpose, I covered each of them with a large glass receiver. Each receiver, however, was provided with a brass rim, having little brass nobs on it, so as to raise its edge from the bottom of the tub, and leave a small opening for the admission of air. The whole apparatus was placed in my library, of which the door and windows were kept constantly shut. This was done on the 17th February last. It is now the 6th of May; and, on examining the flats, I find about forty-six plants in them, apparently of four different kinds; but as they are yet very young, I cannot determine their species with any degree of accuracy." Sir Thomas afterwards found that the seeds which germinated were all highly oleaginous; and the plants produced were the mouse-ear scorpion grass, *Myosotis scorpioides*, the purple archangel, *Lamium purpureum*, and the corn-field spurrey, *Spergula arvensis*. The earth thus experimented upon was taken from the lands of Inveragie. In October 1834, a British tumulus was opened near Malden-castle, by Mr. Maclean, who found therein a human skeleton, and a portion of the contents of the stomach, containing a mass of small seeds, which neither the operation of the gastric juice, nor the lapse of probably twenty centuries, had sufficed to destroy. Many of these seeds were subjected to various careful experiments, to ascertain whether the vital principle was extinct; and Professor Lindley succeeded in raising fruit from several of them, and in consequence ascertained them to be seeds of the common raspberry.

The conditions requisite to vigorous germination—some of them requisite also to even the feeblest and most sickly germination—are the ripeness of the seed, the exclusion of light, a certain degree of moisture, a free supply of oxygen, a certain degree of heat, the presence of some ammonia, and suitable circumstances of soil and season.—The requisite ripeness of the seed, as already hinted, is not economical ripeness but physiological ripeness,—not the ripeness of such hardening and exsiccation as shall fit the seeds to be long preserved or to be employed as food or for economical purposes, but merely the ripeness of completed elaboration of such proximate principles as constitute the proper substances of the seeds, and capacitate them to be stimulated into the process of reproduction. The former kind of ripeness, of course, is necessary for preserving the germinating power of seeds which are kept for a considerable time out of the ground; but the latter kind of ripeness is sufficient for the germination of seeds which are sown immediately after being produced,—and, as already suggested, it presents their plumules and radicles with a far more assimilative condition of their albumen than if they had been allowed to pass into the ulterior ripeness. Mr. Keith, in the very act of combating the notion that unripe seeds will germinate, says, "Radish seed, if left long upon the stalk in a wet season, will germinate even in the pod; also, lemon seed will sometimes germinate in the very centre of its pulpy pericarp, even before the fruit is cut open."

The exclusion of light, though not necessary in many instances to a feeble or even middle-rate germination, is indispensable in all to such a vigorous germination as comports with the objects of cultivation, and essential in some to even the most sickly germination. The covering of seeds with soil no doubt serves principally to maintain the requisite degree of moisture, and to supply the suitable mechanical circumstances for the development of the radicle and the plumule, and the best chemical ones for the reduction of the food of the young plant by means of heat, water, oxygen, and ammonia; but it also promotes the general process of germination, but especially the absorption of oxygen, the evolution of carbonic acid, and the consequent conversion of sugar and starch into mucilage, by the exclusion of light. "The first direct experiments that were instituted on this subject," says Keith, "are those of Ingenhouz. He found that seeds germinate faster in the shade than in the sun, and hence concluded that light is prejudicial to germination. Senebier, who afterwards repeated the experiments of Ingenhouz, drew from them the same conclusion. * * Yet in the face of these facts, M. Decandolle denies that the exclusion of light is a necessary condition of germination, alleging that he has known seeds to germinate though left exposed to the action of the direct rays of the sun. I care not for what may have taken place in M. Decandolle's study or laboratory, or for what everybody is said to know. I only ask whether it would be prudent in the farmer or gardener to adopt a practice founded on the principle here advocated, and to sow his seeds without screening them from the light?" Ragel also denies the connexion between darkness and germination; "for," says he, "though we, in proportion to their size, cover the seeds with sufficient earth to maintain an equal moisture, we also scatter the smaller seeds, such as ferns and heaths, on the surface, and produce the uniform moisture by means of a glass covering." But seeds under a glass covering dimmed internally with moisture are to a certain degree in the shade; and the "seeds" of ferns are more sporules than seeds, and may be supposed to follow the law of cryptogamous reproduction rather than the law of germination; and the seeds of heaths do not differ, in the natural circumstances of their germination, from the seeds of other phenogams of the mountain and the wilderness; and the analogy of the growth of all phenogams—that they absorb carbonic acid and exhale oxygen during the day, and absorb oxygen and exhale carbonic acid during the night—distinctly suggests that the chemistry of germination is a *night* process, or one requiring the exclusion of light. What if the alleged instances of germination in Decandolle's study occurred in consequence of great length in the artificial night of the apartment, and *in spite* of a comparatively brief play of sunshine during the day? The effect of light upon a seed seems to be to reduce its oxygen to a minimum, to fix or thoroughly indurate the carbon of the sugar and the starch, and so to parch the whole of the albumen as to render it irreducible into mucilage. A good precaution in reference to all seeds intended for sowing, therefore, is to keep them in darkness or at least in deep shade.

A certain degree of moisture is known to every cultivator to be essential to germination. Dry seeds, especially if kept in the shade, endure a wide range of temperature, and great and sudden transitions of it, without undergoing any appreciable change; and all seeds intended to be kept from germinating must be preserved in a state of perfect freedom from moisture. A dry seed, if much heated, may lose its vitality, but will sternly refuse to germinate; and may be exposed to the lowest temperature of the frigid zone without sustaining any injury. But a seed which has imbibed moisture, whether it was undeveloped or germinating, freezes in proportion to the degree of its organic excitement or of its actual growth, or according to the climate of its native zone; and it is killed, not so much by the chemical action of the forces at play in temperature, as by the mechanical effect of congelation in rupturing its organism, or in suddenly arresting the progress of the vegetative excitement or development. Either water, or some liquid which chiefly consists of it, is essential to both the commencement and the progress of germination,—essential not only for the supply of hydrogen in the conversion of sugar and starch into gum, and of water in the conversion of gum into mucilage, but for the maintenance of such a mechanical condition of the organism as will promote physical development and increase. Rain, therefore, is always acceptable to the farmer and the gardener soon after they have sown their seeds; and when no rain falls within certain limits of time, water must be artificially supplied, or the seeds will perish. Yet less moisture is required for some kinds of seeds than for others; and a moderated degree of moisture is requisite for all. If moisture be deficient, either in aridity of soil or in drought of weather, the seeds will not germinate; and if moisture be excessive, in either the wetness of soil or the extreme raininess of the weather, the seeds will rot.

A free supply of oxygen, from abundant access and circulation of atmospheric air, is essential to germination. The oxygen not only combines with the excess of carbon present in the albumen, and carries it off in a gaseous form so as to leave the remaining substances in the proper chemical condition to serve as food to the radicle and the plumule, but, in combining with the carbon and effecting its combustion, it steadily generates a valuable proportion of the heat which constitutes another requisite of germination. Some lettuce-seeds introduced by Ray into the receiver of an air-pump, would not germinate while the receiver continued to be exhausted of atmospheric air, but germinated when the air was re-admitted. "If," says Regel, "a number of seeds are put in a little water, which should not exceed more than from 10 to 20 times their bulk, and all communication with the surrounding atmosphere be cut off, so that the water may not absorb any oxygen from it, the seeds do not germinate, although placed in a sufficiently high temperature. When the same experiment is repeated with a proportionately larger quantity of water, they find in it sufficient oxygen to enable them to germinate. Old seeds germinate sooner in pure oxygen than in atmospheric air, when oxygen is by degrees absorbed, and carbonic acid given out. As is well known, the absorbed oxygen burns with the carbon of the plant, and thereby forms the carbonic acid which is emitted; this may be considered as a sort of breathing process, by which when, as in this case, it takes place in a high degree, it produces the high temperature which is observable in germinating seeds when many are together." "The air," says Mr. Lymburn, "yields the oxygen necessary in abstracting the carbon, in the state of carbonic acid, from the starch, and converting it into sugar and mucilage, which may be familiarly illustrated in the sweetness of malting grain and germinating potatoes. A heat of 160° is required to reduce starch to solubility; and it is not exactly known how so much heat is generally acquired. The disengagement of the oxygen sets caloric free; and hence, seeds moistened and thrown into a heap to germinate are found to generate a great heat."

But irrespective of the internal heat generated by the oxygenic combustion of carbon, a certain degree of external heat in soil and air is indispensable. No seed, so far as is known, ever germinated at or below the freezing point of water; for in consequence of the want of sufficient heat to maintain the surrounding moisture in a liquid condition, a seed lodged in soil at or below the freezing point of water is as destitute of a supply of moisture as if it lay in perfectly arid sand or in a perfectly dry atmosphere. Few seeds of weeds, therefore, germinate during our ordinary winters; and yet they are not so internally frozen as to suffer disruption of their organism or destruction of their vitality; for on the return of spring, when the temperature rises, and thaws and heats the ground, they freely germinate. The degree of requisite heat generally admits of a wide range, and yet has well-defined limits, and very considerably varies according to the habits of the plants and the character of their native zone. Seeds which, in storage and in a perfectly dry state, would be uninjured by a prolonged heat of 167° of Fahrenheit, would, if lodged in the soil and supplied with the air and moisture requisite for germination, be killed by two or three days continuance of a heat of from 111° to 122°; and while seeds of British indigens will germinate in a heat not many degrees above the freezing-point of water, the seeds of exotics from the tropics will not germinate in a lower heat than that of our garden hotbeds and greenhouses. On the former of these accounts, the seed in seed-rooms ought never to be exposed to the direct heat of the stove; and on the latter, garden seeds require, according to prevailing practice, to be classified into hardy, half-hardy, and tender.

The presence of ammonia, and also a proper balance or commixation of the other chemical forces, are likewise requisite. A small proportion of nitrogen—not in all cases indeed, but in many —is taken up in the early stages of germination; and this can be supplied only as it occurs in ammonia. See the article Azote. Ammonia probably acts also as both a chemical force without and a stimulating force within; and if not supplied as a proximate principle of animal manure in the soil, it readily obtains access to seeds in its state of solution in rain water. The supply of ammonia, in fact, even more than the accelerating of the play of oxygen, may be a reason why rain water or a dilution of liquid manure acts so much more favourably than waterings from a pond or stream in promoting germination. But the balance of forces, particularly between heat and rain water, and between both and the aeration of the soil, is of the highest moment. "Any one can observe, every year," remarks Ragel, "how the seed sown in the open ground after the first warm spring rains suddenly springs up, if the ground has been sufficiently moist before. But this does not seem to be occasioned by heat alone, as the same effect may be observed in temperate seed-beds, kept regularly warm and moist, when, by removing the sashes, they are exposed to the influence of the atmosphere and a gentle rain. A greater quantity of oxygen seems then to be present in the rain water and the air, which, penetrating with the rain into the ground, excites the seed to the greatest activity." "Alkalies," says Mr. Lymburn, "are also found useful in furthering the process, and are generated whilst it is going on. Perhaps, also, the starch is more soluble in its state of combination than when extracted; and, to all perceptible causes, we must add that vital energy so everywhere necessary, and so little known. In soils which have been properly prepared, by being broken into very small particles, confined air is generated which so increases the heat as to be perceptible even to the touch; and hence the benefits of well pulverized ground, and of covering with pieces of glass and flower saucers, &c., to increase the heat and retain the moisture, and thus further greatly the vegetation of the seeds; and hence the different quantities of heat and moisture requisite for seeds, according as they are dry and farinaceous, or oily and mucilaginous. Very dry farinaceous seeds, as the acacia and others of that tribe, are benefitted by immersion in boiling water; and hence the reason why either heat or moisture of itself is not sufficient, and even hurtful, if carried to excess, either in the germination of seeds or the bud or embryo of the tuber of the potato, as illustrated in the three consecutive springs preceding 1837, in which, from the drought and heat acting on the substance of the newly cut tuber, without the advantage of moisture, the albumen has not been reduced into a soluble food, or in such small quantity as not to be sufficient to produce the development of the bud or shoot."

We have, in a considerable degree, noticed incidentally the chemical phenomena of germination; but we must say something more respecting them in the way of direct notice. Though they may be advantageously exhibited and summarily viewed as consisting simply in the transmutation of starch, sugar, and gum into mucilage by means of moisture, heat, and atmospheric oxygen, yet they are, in reality, greatly more complicated as to both the forces which cause them and the phases which they assume. Even the strictly farinaceous or amylaceous seeds, of which we particularly speak—to the exclusion of the oleaginous seeds, the aromatic seeds, and other classes of diversifiedly constituted seeds—exhibit much multiplicity both of constitution and of chemical change. The nitrogenous principle gluten is a highly important though small constituent; this passes, in the earliest stages of excitement, into diastase, the principle or force of fermentation; the diastase, in combined operation with heat, moisture, and probably other forces, breaks up the dextrine or ultimate principle of the starch, and induces the process or series of changes which constitutes fermentation; this process issues in the disappearance of starch and the abundant substitution of grape sugar; the sugar is closely akin to gum in chemical constitution, and evolves from the fermentation in a hydrated condition, and exists so long in its proper saccharine character as almost to seem the ultimate product, and passes by very insensible degrees into the final mucilage; and conjointly with some or all of these phenomena, oxygen, hydrogen, alkalinity, heat, and electricity play respective or co-operating parts which render the aggregate chemical phenomena of germination exceedingly complicated. Yet several of the constant phenomena, as well as one or two incidental or inducible ones, are not only capable of being separately viewed and tested, but possess much practical interest, either in explaining some accidents to which cultivation is liable, or in suggesting some methods by which germination may be facilitated.

An artificial process of converting the starch and gluten and general albumen of seeds into grape sugar and gum, has been so successfully performed by chemists as beautifully to illustrate the chemistry of germination. First, starch is made into a paste with a little cold water; next, the paste is diluted and stirred up with boiling water till it forms a consistent mass similar to what is used in book-binding; next, some glutinous matter of plants and some of the albumen of seeds are added; and next, the mixture is placed, during several days, in a tolerably high temperature; and it there by degrees becomes sweet and mucilaginous, undergoing a transmutation of its starch, gluten, and albumen into sugar and gum. A similar result may be obtained by boiling the mass with diluted acid, and placing it in a temperature of from 56° to 59° of Fahrenheit, either with or without exposure to the open air; but in this case, a quantity of starchy woody matter, of the nature of lignine, and indissoluble in water, is also formed. The fermentation of the germinating process is essentially the saccharine one, and strictly the same as occurs in the well-known process of malting; and the abundance of grape sugar which results, or even the ulterior mass of saccharine and gummy mucilage, may readily be detected in germinating seeds by the palate, and renders them deliciously palatable to many animals, and constitutes their grand attraction to insects and vermin, affording ample explanation why pease and other seeds, during the period of the saccharine fermentation which precedes and accompanies the development of the radicle and the plumule, are so greedily preyed upon by mice and other notorious garden depredators.

"It was long ago pointed out by M. Raspail and others," says a writer already quoted, "that the ultimate particles of starch consist of a substance similar to gum, which he calls dextrine, enclosed in a shell; this substance is not difficult of solution itself, but it cannot take place till the shell is burst,—which requires a very high heat and the assistance of other substances, as alkalies and the principle called diastase, the agent in fermentation. We thus see that the food of animals and plants needs similar preparation—in so far, at least, as regards this substance. By the assistance of heat, soda, and yeast, which contains diastase, the flour is prepared into a loaf, which is more easily made available as food in the stomach than would be the grain itself; so, by adding alkalies to assist in the action of the natural diastase, formed by the plant itself from the nitrogen of the seed, or by adding yeast where this is deficient, or other substances containing nitrogen to allow the formation of diastase, and by increasing heat in the soil, we assist and increase the efforts of Nature, and a greater produce is the result. It has also been ascertained that electricity is connected with all transformations or changes of organic substances, either as cause or effect: when electricity is present, it accelerates or causes chemical decomposition; and when chemical decomposition takes place, electricity is developed always, says Dr. Carpenter, though perhaps in some instances absorbed again by the new state of the compound. M. Maltuen, in experiments made some years ago with seeds, found that they germinated much sooner at the negative or alkaline pole of a galvanic battery, than at the positive or acid pole; and, following up these discoveries by enclosing seeds in phials of alkalies and acids, he found they germinated quickly in the former, and with difficulty, sometimes not at all, in the latter. Connected with the same subject are the recent experiments of Dr. Horner, on the differently coloured rays of the spectrum; the violet or deoxidizing end produces a chemical effect similar to the negative or alkaline pole, and the red end produces the positive or acid effect by the retention of the oxygen." The alkalies used in the experiments of M. Maltuen were potash and ammonia held in solution by water, and the acids used were the sulphuric, the nitric, and the acetic; and the seeds germinated in the alkalies in 30 hours, and were well developed in them in 40 hours, but took 7 days to germinate in the sulphuric and the nitric acids, and did not germinate in the acetic acid in a month.

Some successful experiments were, a few years ago, conducted in the ordinary course of nursery cultivation, by Mr. Lymburn, founded on the ascertained influence of alkalinity upon germination. "I was induced," says he, "to try the effects of these theoretical opinions on some very old spruce-fir seed in 1836, which had been three years out of the cone. The year before, 1835, some of the same seed did not produce one-sixth part of a crop; and I had good reason to suppose that it would be worse the next. The year before when the seed was damped to accelerate germination, it had a musty fungous smell, and the seed-leaves came up yellow, and, hanging by the ends in the ground, had not strength to free themselves from the soil. In 1836, however, after being damped, I added quicklime in the state of powder, which, besides furnishing an alkali, has a great affinity for carbonic acid; and I kept the limed seed damp, from the use of a watering-pan, for 10 or 12 days; at the end of which time, it had swelled off plump, and had all the sweet smell of the sugar formed in healthy seed when malted in this way; and when deposited in the ground, it was not long in pushing through its seed-leaves as healthy, upright, and dark green in the colour as the first year it was sown; and the seedling spruce was strong and healthy. The reasons why I preferred lime were its cheapness, and the affinity of quick-lime for carbonic acid. As to its alkaline properties, soda is much more powerful; but lime seemed to be that which had produced most effect in the experiments of M. Payen and others on the same subject. The seed must be carefully kept damp till sown, as the dry powder is apt to corrode; and seeds do not suit well to have their dormant powers brought into action without being sustained, which, if far forward and severely checked, may destroy life altogether. Since we experimented as above on the spruce-fir seed, we have tried the quicklime on magnolias and other weak-growing seeds difficult to start, and found them to germinate sooner, and make stronger plants than usual. Some others who have tried it have also found it of benefit. It is to seeds containing their albumen principally in the form of starch, that it will be of most benefit, and to those which have been hurt by long keeping dry, or by being exposed to great heat."

The use of oxygenising substances as artificial aids to germination, is said to have been highly successful in some experiments of Professor Otto of Berlin, and might seem to be strongly recommended by the known great power which oxygen exerts throughout the germinating process. But in the case of farinaceous seeds, any higher proportion of oxygen than about one-third of all the air which has access to them, or a very small proportion more than naturally exists in our atmosphere, seems to be either quite useless or perhaps hurtfully stimulating. Oxalic acid, in particular, has been strongly recommended for its evolution of oxygen; but, in experiments upon starchy seeds, it has not been observed to produce any effect. Different strengths of oxygenic air, indeed, operate with equal benefit upon seeds of different constitution; and probably a high proportion of oxygen may act with all the benefit Professor Otto asserts upon seeds containing much oil,—"which being a substance nearly destitute of oxygen, will therefore require an extra quantity of that substance, more than is found in the atmosphere, to reduce the food to a soluble state." Alkaline action, on the contrary, appears to be nearly as useless to oleaginous seeds as it is beneficial to farinaceous ones. "We never," says Mr. Lymburn, "found damping or liming productive of much benefit to turnips and other oily seeds; but to all containing starch or flour, which is by far the greatest number, the lime, we are convinced, will be of great benefit, and is perhaps the main reason why wheat prepared by steeping in lime and other substances, and potatoes dusted with lime after cutting, have been benefited." A solution of chlorine in water, when applied judiciously and within certain limits, is also known to be a powerful stimulator of germination, and was, for some time, absurdly supposed to produce its effect by the evolution of oxygen; but it requires to be applied with great caution,—for either in over-dose or under wrong conditions, it infallibly destroys the vitality of the seeds. "The same effect," says Regel, an effect similar to the stimulating one of chlorine, "has also been observed in seeds which vegetated entirely in the dark; and as, according to the observations of Göppert, iodine and bromine, in conjunction with hydrogen, produce a similar effect, it appears that both these matters hasten the process of assimilation. It cannot be denied that all these substances accelerate germination; but to the practical gardener, they must be considered as experiments unfit for general practice; for the young plants thus called into existence grow sickly through the excitement, and die off,—which cannot surprise us, as the same effect is seen when plants of cold climates are reared too warmly, and are not placed in a cooler situation after germination." Thus, though the means of artificially promoting germination were more numerously and thoroughly known than they are, they would, in every case, require to be used, not as stimulants, but as restoratives and supplemental forces,—not to overwork the principles fully and healthily existing in the seeds, but either to compensate some loss of these principles, or to bring some correlative and extraneous principle into ancillary action.

The organic phenomena of germination are quite as interesting as the chemical. A seed soon after being placed under the conditions requisite to germination, begins to inhale air, to imbibe moisture, to soften, and to swell. Softening of substance and increase of volume, indeed, will occur also in a dead seed soaked in water, so that these alone do not constitute the commencement of germination; yet they always accompany it, and are the earliest symptoms of its existence. Many a germinating seed also very soon assumes a greenish hue. The radicle is next prolonged beyond the limits which it would attain in consequence of mere soaking; it then penetrates the husk, through the micropylus,—a very small hole in the husk, corresponding to the point of the radicle; and it bursts the husk at this point, continues to make increments to its length by the assimilation of nourishment from the cotyledon or cotyledons, and pushes its way downward into the soil. The cotyledon or cotyledons, unless they be hypogean, burst forth after the perforation or rupture of the husk; the plumule or first real leaf is developed from within or from between the cotyledon or cotyledons; and the rudiment of the future stem, unless the species be stemless, finally rises from the ascending organism, peers up into the air, and, together with the leafy-expansion of the cotyledon or cotyledons, completes the constitution of the plantlet, and terminates its dependence for nutrition upon the food hitherto supplied by the seed.

Malpighi closely observed the organic phenomena of germination as exemplified in the seeds of the gourd. "At the end of the first day, the seeds were considerably swollen, and the envelopes so much moistened that a fluid oozed out of them when pressed with the finger. A hole was also discoverable in the envelopes at the summit of the seed, through which the moisture seemed to be conveyed to the cotyledons, which had already begun to assume the form of seminal leaves. At the end of the second day, the interior membrane seemed to be somewhat torn, and the plantlet somewhat extended, exhibiting on a transverse section taken about the middle, longitudinal fibres, and tracheæ, as well as cells, bark, and pith. The radicle was also distinctly visible. At the end of the third day, the exterior membrane had become more brownish, and its cells more extended, the radicle had burst its integuments, and the plumulet had begun to expand. At the end of the fourth day, the plantlet had perceptibly augmented in size, the radicle was covered with protuberances from which the lateral fibres were to issue, and the interior envelope was somewhat shrivelled, but covering still the seminal and other leaves, in which nerves were now perceptible. At the end of the sixth day, the leaves of the plumulet had escaped from the seed, though still contained within the cotyledons, being soft, but perceptibly covered with hairs. At the end of the ninth day, the plantlet had wholly escaped from its integuments, though the plumulet was still contained within the seminal leaves, yellowish in its appearance, but gradually assuming a tinge of green. At length, its extrication was effected, and the radicle converted into a root, and the rudiments of a stem developed; and on the twentieth day, the plant was complete."

But the comparative period of germination is dependent on both the particular organic structure and the particular chemical composition of the different kinds of seeds. When a husk is of such a nature as all to become speedily soft and tender, the albumen freely absorbs the surrounding moisture, and germination, provided the seed be sound and healthy, is both prompt and rapid; but when a husk is bony, stony, or otherwise intractable by water, the moisture penetrates it only through the micropylus, arrives at the cotyledons only by the radicle, and effects its work with exceeding difficulty and often by imperceptibly and even perilously slow degrees. Shell-enveloped seeds, in fact, are enclosed as if by impenetrable plates and sutures, and often lie lost or dormant during many years; and when cultivated in the garden, or wanted to germinate rapidly, they ought either to be soaked in boiling water, or laid slightly open with a file; or if they are old and of doubtful energy, they ought first to be cut to the albumen in one spot with a file, and then laid for a few days in lukewarm rain-water. The shell-seeds of both monocotyledonous and dicotyledonous plants, and particularly those of acacia, pœony, erythrina, canna, schotia, guilandina, abrus, cassia, adenanthera, bauhinia, and cæsalpinia, have, by means of the filing of their shells, been made to germinate in a short time, mostly in the course of from 12 to 20 days.

Many pericarpal seeds, in consequence of their being not only enveloped in husks, but shrouded within a fruit-covering, are naturally very slow and difficult of germinational excitement; while other pericarpal seeds, in consequence either of the slenderness of their pericarps, or the facility of their own constitution, germinate as readily as naked seeds. Some, as in the Labiatæ and the Boragineæ, lie in fours, at the bottom of a dry hollow cup; others, as in many species of the Rosaceæ, are single or several, surrounded with a thick fleshy cup; others, as in the Compositæ and the Umbelliferæ, are single or in twos, covered with a dry cup, which, in general, grows into the pericarp; and others, as in the grasses, are only surrounded with the pericarp, and in many instances grow into the husky skin of the perianth or involucellum. Hard and stony pericarpal seeds occur in roses, cotoneasters, hawthorns, medlars, plums, and some other Rosaceæ; and when required to germinate rapidly, must be cut or filed in the same manner as shell-enveloped seeds. "The remainder" of pericarpal seeds, remarks Regel, "are divided, according to their formation, into two groups,—those possessing albumen, in which the embryo lies, and those that do not; for as the cotyledons always imbibe the water first and easiest, whereas the albumen is less hygroscopic, the germination of those seeds which have none, but whose interior is entirely filled with the embryo and cotyledons, as in the Boragineæ, Labiatæ, Compositæ, &c., will be more easily effected. The Gramineæ and Umbelliferæ, on the contrary, possess albumen; in the former, the embryo lies outside of the albumen, on which account they easily germinate; whereas, in the latter, the embryo is entirely surrounded by the albumen, for which reason, with the exception of most of the annual or biennial sorts, they are more difficult to vegetate. As they cannot be cut with advantage, it is usual to sow them late in autumn, with other difficult growing sorts; so that when the universal period of germination comes in the spring, they may be sufficiently penetrated with moisture. This method is very well suited for sowing on a large scale; but as the seed often perishes during the winter, and the earth becomes sour, or thickly covered with moss, the preferable way for valuable seeds is to sow them in the spring, after they have been soaked for some days previously in warm water. In this way, very old seeds of Umbelliferæ, in which the embryo seemed entirely dried up, often germinate quickly, of which I give the following as an example:—In the botanic garden at Bonn, in the spring of 1838, four pans were sown with seed, full ten years old, of *Ferula tingitana*, and only those in two of the pans were previously soaked. The latter sprung up all together in from ten to twenty days, while of those in the other pans, which were left for trial, only a few plants came up in one pan in the spring of the following year, the rest of the seed having all rotted." A kind of slimy substance exists in the outer cells of the seeds of the genera salvia, collomia, lepidium, and casuarina, and, when they are surrounded with moisture, attracts the water, swells out, bursts the shells, and envelopes the cotyledons with a sticky mass which keeps them constantly moist, and probably affords important assistance in the nourishing of the plantlets during the earliest stage of their growth.—*Keith's Botanical Lexicon.—Gurten Zeitung.—Brewster's Journal of Science.—Lindley's Theory of Horticulture.—Le Comte Chaptal's Chemistry of Agriculture.—Davy's Agricultural Chemistry by Shier.—The Blights of the Wheat and their Remedies.—Turner's Chemistry.—Liebig's Chemistry of Agriculture—The Gardener's Gazette.—Communications from Mr. Lymburn in Loudon's Gardener's Magazine, and in the Mark Lane Express.*

GEROPOGON. See OLD MAN'S BEARD.

GESNERIA. A genus of brilliantly floral tropical plants, constituting the type of the natural order Gesnerieæ or Gesneriaceæ. This order possesses broad, downy, fleshy-looking or velvety leaves, and gorgeous, tubular, scarlet or purple flowers; and flings uncommon floral splendour over the hothouse collections of Britain, and over the favoured spots of its native growth in tropical America. The plants grow wild principally in the hot damp woods of the northern parts of South America, in places where the soil consists chiefly of decayed leaves and bark; and, in some instances, they overrun trees with their rooting stems somewhat in the manner of our ivy. They possess, as botanical characters, what are technically called an inferior ovary and a parietal placenta. Upwards of 50 species, all stove-plants, have been introduced to Britain; and these belong to the magnificent genera *gesneria* and *gloxinia* and to four others of less note.

The genus Gesneria—or Gesnera as some botanists and nurserymen call it—is one of the most superb in the floral world. It is naturally diffused over all the warmer parts of America, from the southern extremity of Brazil to the parallel of the city of Mexico. Its calyx has an unequally five-cleft limb, and adheres slightly to the ovary; its corolla is tubular, and has five small basal protuberances and a somewhat two-lipped limb, the upper lip emarginate or two-cleft, and the lower one of three divisions; its stamens are four didynamous, with the rudiment of the fifth upper one; its anthers at first cohere in a semisphere; its capsule is dry, one-celled, and imperfectly two-valved; and its seeds are pouch-shaped. All require the heat of the stove, and a soil and situation similar to those of their wild habitat; but some of the most beautiful species, like those of the gloxinia genus, are, while in flower, the fittest possible ornaments of the greenhouse. Only one species, *G. acaulis*, was introduced to Britain before the close of last century; not another species was introduced till 1815; and about 25 species were introduced before 1837. All or nearly all have a richly herbaceous appearance, and most are tuberous-rooted; yet a few have the character of small evergreen undershrubs. We shall particularly notice only one species—a very fine one, introduced from the south of Brazil in 1834—as a specimen of the genus.

The rocky or rock-inhabiting gesneria, *G. rupestris*, is a very low-growing tuberous-rooted plant. The root is a large and somewhat flattened tuber, with a few short fibres; the stem is so very brief a prolongation of the tuber as to seem of very doubtful existence, so that both the leaves and the flower-stalks look as if growing on the crown of the tuber; its leaves are only two and opposite, each with a downy footstalk about an inch in length, and inserted from a quarter to half an inch within the margin; the limb of each leaf is ovate, slightly peltate, from 3 to 8 inches in length and from 3 to 6 inches in breadth, crenately toothed, rather thick, bullate, and convex, dark and nearly glabrous above, pale and with a scattered glandular pubescence below, and much thickened on the midrib and the veins; the flower-stalks are numerous, erect, two or three inches long, simple or more frequently branched in the same manner as the cymes of the other gesnerias, but in a vertical instead of a horizontal direction; each flower-stalk, if the plant be vigorous and freely-flowering, bears so many as 8 or 10 flowers; each pedicel has at its base a linear bract, and the whole cyme is pubescent and glandular; the calyx is pubescent and as long as the tube, and has the divisions of its limb lanceolate; the corolla, in a good plant, is an inch and a half in length, glabrous, slightly curved, and of a rich red colour; the limb of the corollar tube has four broad, rounded, spreading divisions, with the upper lip comparatively broad, and more or less deeply divided into two: the filaments of the stamens are filiform, and as long as the tube; the anthers are yellow and cohering; the style is glabrous; and the ovary is pubescent. This magnificent plant was introduced from Brazil to the Botanic Garden of Berlin, and thence, in 1834, to the Botanic Garden of Edinburgh; and it was liberally distributed from the latter, so as speedily to become a somewhat well-known favourite.—Most of the other introduced species have scarlet-coloured flowers, and a height of about two feet.

GESTATION. The time during which a female, who has conceived, carries the embryo in her uterus. Among birds and all other oviparous animals, a real gestation cannot exist, because the eggs detach themselves from the ovaries, pass along the oviducts, and are deposited as soon as they are formed. With these animals, gestation becomes superseded in general by incubation, to which it is greatly analogous, and the former function may thus be considered as little else than an internal incubation. The apparent design of Nature, in both cases, is to favour the gradual development of the embryo or fœtus—

the first rudiment of the new animal resulting from conception. It is also observed, that the rapidity of growth in the fœtus, whether during the gestation of the viviparous animals, or the incubation of the oviparous, always diminishes in proportion as the fœtus approaches the time appointed by Nature for its birth. The length of the period of gestation, like that of incubation, varies greatly among the several genera and species. It further obtains certain accidental variations, which appear to depend upon the age of the mother, her state of health, an increase or diminution in the velocity of the circulation, the quantity or quality of the food, and all those causes, derived from the influence of climate, soil, shelter, and the different kinds of treatment which these animals receive from man. The period of gestation may also be either shortened or prolonged, according to the temperature which prevails during that interval. It is a matter of common observation among graziers, that two cows, though fecundated on the same day, will yet produce at an interval of several weeks. The variation among sheep under similar circumstances amounts to a few days, but in general, this difference among domestic animals of the same species may extend as far as twenty days. It commonly happens in all those species, where the individuals take a long time in arriving at their full growth, that the period of gestation is considerably prolonged; and the converse is equally true; for in all those species which are very precocious, the time of gestation is extremely short. This rule is not, however, without many exceptions. Thus, the goat and sheep are capable of reproducing at the age of two years, and have commonly attained their full growth at this period, while their ordinary time of gestation is about five months. On the other hand, a lioness at the 'Ménagerie du Muséum,' in 1801 and 1802, seemed unfit for procreation before the age of two years, and yet she produced after a gestation of 108 days only, or rather more than three months and a half. The duration of gestation seems further to depend upon the comparative volume of the species; this rule, however, is by no means invariably preserved. Thus, the ass and zebra, though less in volume than the cow and buffalo, employ less time in performing this function than the latter species.

It hence appears that the duration of gestation varies in different animals, and the empirical laws deduced from multiplied observations are not without many exceptions. By combining, however, the general organization of the mammalia, with the time necessary for each animal to arrive at its full growth, as well as with the comparative bulk of the females, it is possible to obtain a general and definite result; while the characteristic thus obtained may, with propriety, be added to those which commonly serve to distinguish the leading groups of mammalia. Thus in man, nine months is the well-known period of gestation. Among the quadrumana, it is also nine months for the larger species, but only seven for the smaller. In the carnassiers, gestation endures six months with the bear; 108 days with the lion; nine weeks with the Arctic fox (*Canis lagopus*); from 55 to 56 days with the cat; the same period for the martens and weasels; from 62 to 63 days with the dog; and nine months with the morse. Those mammalia which experience the shortest term of gestation are unquestionably the animals belonging to the order marsupialia. Among the large kangaroos, for example, the young are scarcely more than an inch in length, when they first attach themselves to the breasts of their mother, although the full-grown animal is at least five feet in height. Gestation is also of short duration in the rodentia, being only four months in the beaver, one of the largest animals of this order. It is still less in the smaller rodentia, being from 30 to 40 days in the hares and rabbits; 31 days in the dormice; four weeks in the squirrels and rats; and three weeks in the Guinea pig. Among the pachydermata, gestation is of much longer duration; it endures with the elephant from 22 to 23 months; it lasts from 11 to 12 months in the horse and ass; in the zebra for a year and some days; in the tapir, from 10 to 11 months; in the hog and boar for four months. Further, it endures among the ruminantia, for twelve months in the dromedary; for nine months in the female buffalo and cow; for eight months and some days in the females of the common red deer (*Cervus elaphus*), the fallow deer (*C. dama*), and the rein deer (*C. tarandus*); five months and a half for the roebuck (*C. capreolus*); five months for the goat, the sheep, the mouflon, and several antelopes. We are hitherto without any positive information regarding the period of gestation among the cetacea.

It is evident that the number of births appropriate to each species will mainly depend upon the average length of each period of gestation. On this account, the larger species do not produce every year, especially when a long term of lactation also intervenes. The smallest species, on the contrary, multiply most prodigiously, and it may be generally stated that, if we except the rabbit and hog, both the number of births, and the number of young ones at each birth, are in general more considerable in proportion as the size of the animal is less. The guinea pig can produce every two months; the hampsters, the rats, the mice, the field-mice (*Arvicola*), and the shrews, do not produce less than three or four litters in the course of the spring, summer, and autumn. With respect to the exceptions above stated, it may be inferred that the abundance of food which those animals obtain from man has modified their nature: for we find that in all the wild species which approach nearest to these domestic races, the number of young produced at each birth is always less, as may be remarked in the hare, producing only from three to four young at a birth, and the female of a boar from three to eight.

The number of young in each litter also bears an immediate reference to the length of gestation. At each birth, man and the quadrumana commonly produce only one, very rarely two or more, and the cheiroptera bear two. Among the carnassiers, the tiger produces one; the lion, three or four; the cat, four or five; the white bear, two; the brown bear, from one to three; the wolf, the fox, and the adive, from four to five; the arctic fox, from five to seven; the badger, from three to four; the mole, from four to five; and the seals, one or two. Among the marsupialia, the opposums produce from eight to ten, but the kangaroos only one or two. Of the rodentia, the beaver bears two or three at a birth; the rabbit from four to eight; the hampster from five to six; the common rat, the mouse, and the brown rat, or surmulot, from eight to ten. The agouti bears four, according to Laborde, or only two, according to Buffon and d'Azara. The garden dormouse produces five or six young ones at a birth; the common dormouse three or four; the guinea-pig from seven to ten; the common squirrel from three to five; and the marmot three or four. Among the edentata, the sloths produce only one, as also the ant-eaters, while the armadilloes bear four at each of their births, which occur pretty frequently. With the exception of the pig, the pachydermata produce but few young at a time; thus, the elephants, the rhinoceroses, hippopotamus, tapir, and all the horse genus, have only one; the peccari has two, while the female pig will bear as many as twelve and even twenty. All the ruminantia produce two or more, excepting the largest species, which have only one. The cetacea produce, in general, but one young one at each birth. It most commonly happens that the first and last litter of each animal are deficient in number, and often also in strength. It thus appears, that the largest and most formidable species are far less fruitful than the smallest and weakest. Not only are the former longer in arriving at their age of puberty, but their periods of gestation and lactation are prolonged, and the number of young at each birth is, in general, less. Thus, while the tiger produces only one cub at a time, the wild cat will bear four or five. "In this manner, the lower tribes become extremely numerous; and, but for this surprising fecundity, from their natural weakness, they would quickly be extirpated. The breed of mice, for instance, would have long since been blotted from the earth, were the mouse as slow in production as the elephant. But it has been wisely provided, that such animals as can make but little resistance, should at least have a means of repairing the destruction, which they must often suffer, by their quick reproduction; that they should increase even among enemies, and multiply under the hand of the destroyer. On the other hand, it has as wisely been ordered by Providence, that the larger kind should produce but slowly; otherwise, as they require proportional supplies from Nature, they would quickly consume their own store; and, of consequence, many of them would soon perish through want, so that life would thus be given without the necessary means of subsistence. In a word, Providence has most wisely balanced the strength of the great against the weakness of the little. Since it was necessary that some should be great and others mean, since it was expedient that some should live upon others, it has assisted the weakness of one, by granting it fruitfulness; and diminished the number of the other by infecundity."

Among all the monogamous species, such as several rodentia, bats, and moles, a kind of family is established during the interval, necessary for the support of the young, when the father and mother divide the cares of their family between them. A mutual tenderness seems to prevail in these little societies, which are connected by affection alone. Each animal shares in the common labour, and each partakes in its share of the produce. These societies, among many rodentia, are almost as intimate as those of man, whose articulate language is here supplied by a natural system, where cries and gestures supply the place of words. But when once the young have become strong enough to maintain themselves without the aid of their parents, they become estranged, and form other family connexions. They cease to recognise each other after a certain time, and become wholly indifferent to the nearest ties of blood. They even do not scruple to contract alliances with their nearest relations of the other sex. It is seldom, however, that the young show any partiality of this kind towards their older relations. On the contrary, this anomalous feeling nearly always exhibits itself in the attachment of the older for the younger animals. With polygamous species, such as the ram, goat, and bull, there exists no attachment of relationship on the part of the male. Possessing several females, he has no affection for his young, and the mother alone takes charge of them, during their unprotected state of infancy. In these species, the mother bears a much less number of young at a time than the monogamous kinds, and hence the female suffices to nourish and protect them. The polygamous species being generally also herbivorous, and the young being capable of walking from the moment of their birth, they are sooner able to subsist without the aid of their parents than the carnassiers. The latter, accordingly, are monogamous in general. Their young are often born with their eyes closed, and with imperfect senses.

Animals which produce more than one young one at a birth usually bear an even number. This proceeds from the circumstance that each ovary supplies its contingent of ovaria to be fecundated. In the same manner, Nature assigns an even number of mammæ to these viviparous quadrupeds. Human twins are most commonly both males or both females, although sometimes they are male and female, but these last happen more rarely. Four at a birth is very uncommon in the human species. This gemelliparous property is often peculiar to particular families. Twin brothers are often the fathers of twins at several successive births, and in one case, a second marriage having taken place, the latter wife produced twins likewise. In this kind of generation, it is probable that the impregnation of the two ovaries happens at the same moment, especially as we know that animals, habitually multiparous, only require a single union, although doubtless superfetation may also be induced by subsequent unions.

The young of nearly all mammalia are born with their eyes closed, and do not open them for several days. The mother cuts the umbilical cord with her teeth, and, even without being carnivorous, devours the membranes or after-birth, as in the cow, the sheep, and many others.—*Cuvier.*

GETHYLLIS. A genus of tuberous-rooted, ornamental, Cape-of-Good-Hope plants, of the amaryllis family. Five species, all white-flowered and from 6 to 10 inches in ordinary height of flower-stem, have been introduced to British gardens.

GEUM. See Avens.

GIBBING. See Backing.

GID. See Hydatid.

GIDDINESS. A well known symptom of numerous affections of the brain and the stomach in man and the lower animals; and thence loosely identified by multitudes of the rural population with some specific diseases of the animals of the farm. Apoplectic affections are sometimes called giddiness. See the article Staggers. Epileptic affections are more frequently called giddiness; and they, at the same time, bear the popular names of fits, sturdy, megrim, and turnsick. See the article Epilepsy. A peculiar affection in poultry is usually called giddiness. See the article Megrim. A hydatidal disease of the brain of the sheep, of somewhat common occurrence, bears many popular names of an intendedly descriptive kind,—among the rest, gid, giddiness, sturdy-gig, turnsick, goggles, and blob-whirl. See the article Hydatid.

GILIA. A genus of ornamental, herbaceous, American plants, of the polemonium family. It became known in Britain only in 1827; it contributed, in the course of the next ten years, about 14 species to our flower-gardens; and it has, for some time, been one of the most popular genera on our seedsmen's lists of hardy annuals. The calyx of its plants is campanulate and five-cleft; the corolla is funnel-shaped or subcampanulate, with five-parted limb, and entire, obovate segments; the stamens are inserted at the throat, or scarcely within the tube; the anthers are roundish or ovate; and the cells of the capsule are many-seeded. Four or five of the species introduced between 1827 and 1837 were, for some time, regarded as a separate genus under the name of Ipomopsis, and are distinguished by the protrusion of the corollar tube much beyond the calyx; and the rest of the genus comprises two groups,—the one distinguished by the shortness of the corollar tube, accompanied with a spreading habit of the limbs,—and the other distinguished by the shortness of the corollar tube, unaccompanied by any spreading habit of the limbs. The latter of these groups is the strictest or most characteristic portion of the genus; and, in common with the Ipomopsis group, it has alternately placed and pinnately cut leaves; while the other group has sessile, oppositely placed, and palmately cut leaves, and, in allusion to the last of these characters, has been called Dactylophyllum.

Three very favourite hardy annual species of Gilia proper, or Eugelia, are *G. capitata*, a blue-flowered plant, with headed or spherically agglomerated inflorescence, and about 2 or 2½ feet in height; *G. tricolor*, a lilac and purple-flowered plant of 12 or 15 inches in height; and *G. achilleæfolia*, a purple-flowered plant of about 20 inches in height. But the most beautiful plant of the genus is *Gilia coronopifolia*, formerly called *Ipomopsis elegans.* This comprises one variety from Carolina and another from Northwestern America, which are sometimes regarded as distinct species,—the latter under the name of *Gilia pulchella;* and though a perennial in its native regions, it lives only as a biennial in Britain. Its root is fibrous; its stem is simple, and from 3 to 5 feet high, and has a glandulous pubescence; its radical leaves are crowded, pectinate, dark green, somewhat fleshy, and sparingly pubescent; its upper leaves are undivided; its flowers are panicled, aggregated, and nodding, with the tube of the corolla scarlet or reddish, the upper surface of its limbs beautifully spotted, and its throat whitish, and they bloom from July till September. The seeds of this handsome plant should be sown in autumn; its seedlings transplanted into pots and protected in a cold frame or some similar situation during winter; and the plants finally set down in a shady situation in the border.

GILL. A rill or little brook; also, a pair of wooden wheels.

GILLS. The thin flat laminæ which are disposed edgeways and radiatingly on the under surface of the pileus of many of the larger fungi. In some species, they grow in separate laminæ; in others, they grow in pairs or sets; and in others, they are fused into one another in various arrangements of inosculation and junction.

GILLENIA. A small genus of hardy, perennial-rooted, herbaceous plants, of the rosaceous tribe. It was constituted by Moench out of two species formerly ranked as spiræas.

GILL-GO-BY-THE-GROUND. See Alehoof.

GILLIESIA. A small genus of plants, constituting the type of the small natural order Gilliesieæ or Gilliesiaceæ. This order has some affinity to squills and hyacinths; yet, in its distinctive characters, it is very curious. Only one plant of it, *Gilliesia graminea*, exists in Britain; and this was introduced about 20 years ago from Chili. It is a grass-like, bulbous-rooted, greenish-flowered plant, with a flower stem about a foot in height, and blooming in the early part of autumn.

GILLIFLOWER. See Stock.

GILT. A young female pig.

GIMMER. A young ewe. A gimmer-lamb is a ewe-lamb; and a gimmer-hog is a first-year ewe.

GINGER,—botanically *Zingiber*. A genus of tropical, ornamental, herbaceous plants, of the order Scitamineæ, and sometimes regarded as the type of that order. Upwards of a dozen species, varying in height from 2 to 10 feet, and mostly carrying pink, red, or yellow flowers, have been introduced to the hothouses of Britain, principally from India.

The officinal ginger, *Zingiber officinale*, is universally known to physicians and veterinarians, for the eminently carminative properties of its roots. It naturally abounds on the coast of Malabar, and also inhabits South-eastern Asia and the adjacent islands, and was at one time extensively cultivated in Jamaica; and it was introduced from India to the botanical collections of Britain in 1605. The root is of the size of a finger, knotty, creeping, and produces three or four sterile stems, about two feet high, which are provided with lanceolate leaves, seven or eight inches in length, disposed alternately on two opposite sides of the stem, and nearly horizontal. The flowering stems are situated at some distance from these, and are covered with membranous scales, of which the superior ones are largest, and each envelopes a flower. The root has an aromatic, pungent taste, and is much used by the inhabitants of its native regions as a condiment, and sometimes, when green, mixed with other herbs, as a salad. It is also candied, and makes an excellent preserve. It is used medicinally by the human subject, as a carminative, and in debility of the stomach and alimentary canal; and it serves as one of the best and most common cordials or aromatics for both horses and cattle. Ginger was known to the Romans during the time of the emperors, and is described in Pliny as being brought from Arabia.

GIRDLING. The removal of a belt of bark from a living tree, with the design of arresting the ascent of the sap, and in consequence killing the tree. This operation is a common method of effecting clearances in the woods of America; and requires to be performed early in the spring, before the commencement of the annual alburnous deposition. It promptly kills most kinds of trees; yet is sometimes baffled for some years by the sugar maple and the entire-leaved tupelo.

GIRTH. The circumference of the stem of a tree, of the body of an animal, or of any other cubical part of an organized and living being.

GITHAGO. See Corn-Cockle.

GLADIOLUS. A genus of very beautiful, exotic, tuberous-rooted plants, of the iris tribe. About 50 species have been introduced to Britain; and a few of these are among the most gorgeous beauties of the parterre, while some make a conspicuous and splendid appearance in the greenhouse. Most of the known species of gladioli inhabit the sandy wastes of the Cape of Good Hope, and others are natives of Russia, Turkey, Tauria, and the South of Europe. The greater proportion are handsome; some are superlatively beautiful; and a few are deliciously fragrant. The gladioli have, for a number of years past, figured largely as florists' flowers, and at floricultural exhibitions, and have, to a considerable extent, been improved by hybridizing and artistic cultivation; and yet, in a great degree, they have happily escaped the vulgarizing and murderous effects of popular eclat and fashionable patronage.

The common or corn-flag species, *G. communis*, is noticed in the article Corn-Flag. The Turkish species, *G. byzantinus*, was introduced to Britain from Turkey in the early part of the 17th century. Its flowers are larger than those of the common species, and of a rich purple red colour, with a pale feather, and bloom in June and July. A variety of this species has white-coloured flowers, with a dark feather.—The fairest species, *G. blandus*, was introduced, about 70 years ago, from the Cape of Good Hope. It has broad leaves, and large, flesh-coloured flowers, with pale red spots on the lower petals; and it grows two feet high, and blooms in June. One variety of it has pure white flowers; another variety has lilac or pale purple flowers; and another has light pink flowers, with crimson blotches near the base.—The superb or cardinal species, *G. cardinalis*, was introduced from the Cape of Good Hope toward the close of last century. Its leaves are ensiform and very glaucous; its stem is about two feet high and gracefully bending; and its flowers have a brilliant scarlet colour, with a broad white streak or feather on each of the three lower petals, and bloom in July and August. One variety of it has pale scarlet flowers, with a white feather; and another has pale crimson-shaded flowers.—The bundle-flowered species, *G. floribundus*, was introduced from the Cape of Good Hope during the latter half of last century. Its leaves are ensiform, broad, and large; its stem is 12 or 15 inches high, and evolves flowers from a large proportion of the upper part of its length; and its flowers are spreading, very large, and of a flesh colour, with a lively red bar on each petal, and bloom from May till July,—yet may be so treated as not to bloom till late in autumn.—Miller's species, *G. Milleri*, was introduced from the Cape of Good Hope about the middle of last century. Its stem is about 18 inches high; and its flowers are large and spreading, and have a white colour changing to sulphur, with purple streaks on the lower petals, and bloom in April and May.—Morton's species, *G. Mortonius*, was introduced from South Africa in 1837. Its stem is about 18 inches high; its leaves are broad; and its flowers have a dingy rose or somewhat scarlet colour.—The parrot-like or Natal species, *G. psittacinus* or *G. natalensis*, was introduced from the Natal river in 1830. Its stem is 3 or 4 feet high, and bears a comparatively long spike of flowers; its leaves are broad and ensiform; and its flowers are large, somewhat arched in the form of a parrot's head, and very beautifully mottled with colours of yellow and scarlet, and bloom in August.—The blush-flowered gladiolus, *G. pudibundus*, is an English hybrid. Its stem is 2 or 3 feet high; its leaves are broadly sword-shaped; and its flowers grow in two rows on a long spike, and are large, spreading, and blush-coloured, and bloom in July and August. —The branching species, *G. ramosus*, is a native of the Cape. Its stem is branching and about 4 feet high; its leaves are broad; and its flowers grow on the branching stem, are large, spreading, and of a light rosy pink colour, and bloom in July.—The wave-leaved species, *G. undulatus*, was introduced from the Cape nearly 90 years ago. Its stem is from 12 to 18 inches high; its leaves are lanceolate; and its flowers are large, spreading, scentless, and of a pink colour, and bloom in April and May. One variety of it has pale pink flowers; and another has cream-coloured or yellowish flesh-coloured flowers.—Among well-known hybrids are *G. atroroseus*, 18 inches high, and deep-red flower, with pale feather; *G. Dobrei*, 18 inches high, and rosy-lilac flower, with citron-coloured feather; *G. expansus*, 2 feet high, and large red flower, with crimson feather; *G. Herbertii*, 18 inches high, and rosy crimson flower, with a deeper coloured feather; and *G. patens*, 18 inches high, and a blush flower, with rose-coloured feather.

All the species and hybrids which we have enumerated are either quite hardy in themselves, or may with proper care be raised as hardy plants in the open ground; and florists' varieties, of similar habit, are already very numerous, and are augmented by the annual importation of hundreds of seedlings from Guernsey and the Continent.—A notice of the half-hardy or greenhouse species and hybrids would transgress our requisite limits; and we shall merely name some of the best known and the most worthy of cultivation: *G. alatus, angustus, campanulatus, carneus, cochleatus, cuspidatus, Colvillii, debilis, edulis, gracilis, hastatus, hirsutus, hyalinus, numaquensis, recurvus, tenellus, tristis, trimaculatus, viperatus, versicolor*, and *Watsonianus*.

The hardy gladioli produce a most gorgeous display in the flower-garden, whether planted in large beds, considerable masses, or single patches; and some are so accommodating as to grow in any kind of garden soil, old or new, rich or poor, humous or arenaceous, provided it have proper depth, and be duly drained and pulverized. But to do any species full justice, it ought to be planted in a bed or mass by itself, artificially prepared to the depth of 18 inches, the lowmost six inches occupied with rough gravel, small stones, or broken bricks to effect thorough drainage, the next three or four inches occupied with roughly chopped turfy or loamy soil to serve as a reservoir of moisture in dry weather, and the remainder or all the upper part of the space occupied with a compost of one part of good ordinary garden soil, one part of sandy loam, one part of turfy peat, and one part of coarse drift sand, well prepared during the winter, and so deposited as to allow for subsidence and for the rejection of surface-water. The proper time of planting, whether nakedly in the soil or by the plunging of pots, is the latter part of March or the beginning of April. The greenhouse species should be potted early in February, in pots rather deep than wide, with the tops of the bulbs about an inch below the surface of the soil.

GLADWYN. See Iris.

GLAIR. Mucous matter in the excrement of horses and cattle. It sometimes appears in great quantity, and indicates a high state of disease, during disordered or morbid conditions of the stomach or the bowels.

GLAND. A fleshy and roundish organ in the animal system. Glands are exceedingly varied in their internal structure, and appear to perform exceedingly varied functions; but few if any are well understood by physiologists, and some are not understood at all. The absorbent glands are somewhat numerous in the human being, the horse, the ox, and other mammalia, and appear to perform important offices in their absorbent system; yet they are few in birds, and do not at all occur in fishes and the amphibia. See the article Absorbent System. The secernent glands have various forms and sizes, and separate the several fluids of the secretional and excrementitional systems from the blood. The vascular glands comprise the spleen, the thymus, the placenta, the renal capsules, and the thyroid glands, and appear to be congeries of veins and arteries without any externally opening duct; but are imperfectly known as to structure, and altogether unknown as to function.

GLAND. A small callosity on the surface of any part of a plant. All vegetable glands consist of cellular tissue, and differ from hairs or pubes chiefly in having a more complex structure and in being filled with liquid secretions; and—with the exception of those called lenticular—all, or almost all, appear to act as secreting organs. They abound on the stems, petioles, and leaves of many plants; and they sometimes occur also on the several parts of flowers, whether calyx, corolla, stamens, or ovary. Those of the birch-tree and the moss-rose are situated on the stem and the branches; those of the sundew, on the upper surface of the leaves; those of the tamarisk, on the under surface of the leaves; those of the five-stamened willow, between the serratures of the margin of the leaves; those of very many species, on the footstalks of the leaves; those of numerous species, at the base of the leaves; and those of a few species, particularly of the rue family, on the apex of filaments or summits of hair-like pubes. Most, as in the apricot, are simply sessile; but a few, as in the nettle, are sessile, with a projecting pube; and some, as in the rose, are supported on a pedicel. M. Guettard, a French phytologist, distributes them into six classes,—miliary glands, of similar form to the grains of millet, occurring sometimes in regular sets or groups as in the fir, and sometimes in crowded clusters as in the cypress; vesicular glands, with the appearance of minute transparent bladders, as in the leaves of the myrtle; scaly glands, with the form of either circular or oblong scales, as on the fronds of ferns; globular glands, with the appearance of minute globules, as on various species of the labiate-flowered order; cup-shaped glands, with a cavity like that of a mimic cup, as on the petioles of the passion-flower and the nectarine-tree; and lenticular glands, with an elongated form somewhat like that of a lens, as on the young shoots of the birch and many other kinds of trees. The liquid secretion of some glands, as in the guelder-rose, is saccharine; and that of others, as in the moss-rose, is resinous and fragrant.

GLANDERS. A disease of horses, long considered the most formidable with which the veterinary surgeon is called to contend, and even said to form the *opprobrium medicorum* of the veterinarian's art. What renders this a matter of surprise to an indifferent observer, is, that glanders is an affection which, in the generality of cases, for some considerable time does not appear to detract in the slightest degree from the animal's ordinary state of health; and so far is it, while it continues in this passive stage, from lowering his condition, that he not only continues to enjoy health, but, from the state of inactivity into which he is probably thrown in consequence, absolutely gets fat; hence it is we hear people say, that it seems impossible, under such circumstances, their horses can be diseased.

Glanders appears to be a bad variety or virulent modification of the same disease as farcy, and to arise from the worst kinds of the same causes which produce that disorder. See the article Farcy. An opinion long prevailed that glanders is entirely a specific disease, propagable only by infection or contagion; but this opinion is now exploded among multitudes of enlightened veterinarians, and remains unmodified among hardly any. A few veterinarians have even become so bold as to assert that glanders is never, in any proper sense of the word, infectious or contagious; and M. Galy, a French veterinarian, about ten years ago conducted such successful experiments, in the perfectly harmless mixing of glandered horses with healthy ones, as to draw from the Inspector-General of the army studs a proposition for reconsidering an old ordinance which required all glandered horses to be destroyed. But though we see nothing like sufficient evidence for this extreme and very sanguine opinion,—and though we feel bound to urge all farmers and others to adopt, as in old times, every prudent measure for preventing the possible contact of glanderous matter with the bare or abraded surface of a healthy horse,—we by no means think glanders the terrible affair which all the old horse-doctors regarded it, and are of opinion that it is infectious or contagious only when bad treatment and serious debility predispose to it, and that, in almost all cases, it is either immediately or remotely due to previous disease, foul stabling, bad food, impure air, currents of cold air, frequent and sudden transitions of temperature, or, in general, to induced morbidness of constitution, or impairment of general organic energy, or structural enfeeblement of the aerating organs. Glanders was, in former times, quite rife among cavalry horses; but since the modern improvements in stabling, it has been almost completely banished.

Most writers make a division of glanders into *acute* and *chronic:* the former being that which, when once set in action, and when not arrested by prompt and suitable remedial treatment, proceeds regularly through its course, and at last ends in destruction; the latter, a stage in which the disease appears to be stationary, or at all events one in which it makes no perceptible inroad upon the general health.

Acute Glanders consists in an ulceration of a peculiar character of the pituatury membrane, (the membrane lining the cavities of the nose) which is commonly accompanied with glandular swellings under the jaws. These ulcerations at first assume the appearance of pin-holes, only that they are shallow, instead of deep, and have thin indented edges; they exude a purulent matter, which so completely envelopes them, that their true character cannot be well made out until their surfaces are wiped dry. They exist in most numbers upon the middle or partition of the nose; but they are also often found grouped in the hollow within the doubling of the nostril. By interunion, one with another, they at length form broad ulcerous patches which grow deeper and deeper until they threaten destruction to the septum nasi and turbinated bones: a period at which the sloughing and suppurative action is occasioning so much defluxion that there is always danger of suffocation; which is, in fact, the common way acute glanders ends in death.

Chronic Glanders consists in a purulent ill-conditioned discharge from the nose, commonly but from one nostril: this is also the case in the acute form; but it is not so *generally* confined to one side of the head as the chronic. The difference between the two is, that in the chronic there is *no* ulceration. The source of this affection is the frontal sinus; if that be opened with a common gimble, and a feather, introduced into the hole, be withdrawn smeared with *matter*, we may be certain the disease exists.

Almost all old veterinary writers spoke despairingly of a cure for glanders; and even some of our best modern ones continue to speak despondingly of it; and multitudes have striven and toiled and groped in search of a specific, almost as the old alchemists did in search of the philosopher's stone. Yet, except in remote districts, or in extraordinary circumstances, the time has gone by when the appearance of glanders in a horse was a signal for killing him. "This disease," says Mr. Winter, in his able treatise on 'The Horse in Health and Disease,' published in 1846, —"This disease is not now considered so hopeless as it was formerly. Numerous cases of successful treatment show that it can be subdued by therapeutic agents. The great drawback to the establishment of a judicious system of combating this affection has been an unscientific and unwarrantable recourse to violent medicinal preparations. All the most active poisons have been employed again and again without success. In pursuance of this blind, empirical plan, Mr. Coleman gave, in the vain hope of finding a specific, 'the various preparations of arsenic, antimony, copper, zinc, mercury, &c., hellebore, aconitum, digitalis, hyoscyamus, cicuta, belladonna, &c., &c., but all without any specific or curative effect;' while some of these substances given in moderate doses have since been discovered to possess considerable curative influence over the disease. The affection being supposed to be generated by, as well as to generate, an animal virus or poison, powerful medical poisons were introduced into the system to combat it. A more correct pathological knowledge of glanders has led, and will lead to a more rational method of treating it. If the complaint spring from such causes as have been enumerated, no plan of treatment can be successful unless based on a removal of them. Debility being both a cause and a result of the disease, our aim should be directed to rouse, support, and strengthen the powers of the constitution. Accordingly, such remedies as have a stomachic and tonic action have been found most beneficial. Mr. Sewell has cured many cases of confirmed glanders by administering a solution of sulphate of copper in moderate doses. Mr. Vines prefers cantharides, bark, capsicum, cubebs, ginger, gentian, quassia, and such agents as improve the health and condition, by increasing the appetite, and through it the powers of the circulation. By adopting such principles, I cured more than fifty cases of glanders in the stables of the Egyptian Transit Company. The salts of iron, such as the sulphate, carbonate, and ioduret, are of essential service in glanders. Considerable benefit often arises from the continued use of the sulphuret of antimony combined with tonics. Chyryata, as a vegetable bitter and stomachic, is a powerful adjunct to mineral preparations, or to cantharides. When cantharides are employed, not more than three, four, or five grains should be given daily, as there will be less danger of over-dosing; for as soon as the animal is observed to refuse a portion of his usual rations, all that is necessary is to desist from the medicine for a day or two. Since nearly all the medicines possessing a curative effect on glanders act by restoring the health by the improvement of the digestive powers, strict attention must be paid to the diet. The food should be of the best and most nutritious character, given without restriction, the quantity being alone governed by the extent of the animal's appetite,—speared corn, malt, sound oats, beans, and clover-hay, with an occasional recourse to green food or carrots. The horse should not be put to work, but daily exercise in the open air should be taken."

GLANDIFEROUS TREES. The oak, the beech, the sweet chestnut, and other trees which produce fruit in the form of what is popularly called acorn or mast. This fruit is technically designated glans; and hence the epithet glandiferous. The glans is a one-celled and indehiscent fruit; and is either single and partly naked as in the oak, or double and completely enveloped as in the beech.

GLANS. See Glandiferous Trees.

GLASS-EYE. See Amaurosis.

GLASSWORT,—botanically *Salicornia*. A diversified genus of plants, of the goosefoot order. Another genus of the same order, long celebrated in the commercial world for its abundant and rich produce of alkaline salts, the genus *Salsola*, has sometimes been popularly called glasswort, while the genus Salicornia has been termed, for the sake of distinction, jointed glasswort; but the former is now generally called saltwort, and the latter is left in sole possession of the name glasswort. Four species of salicornia grow wild in Britain; two species have been introduced from respectively Arabia and Siberia; and about a dozen other species are known. We shall specially notice only the indigenous species.

The herbaceous glasswort, *Salicornia herbacea* grows on the shores of many parts of Britain Its root is small, fibrous, and annual; its stem is green, bushy, ligneous, very tough, and about a foot high; its branches are opposite; and its flowers are produced in numerous short-jointed spikes, and are apetalous and very inconspicuous, and bloom in August and September. The whole plant abounds in saline juices and possesses a saline taste; it was formerly burnt, in common with the richly alkaline fuci, in the manufacture of kelp; it is greedily eaten by sheep and cattle; and it is sometimes gathered and used as a substitute for rock samphire.—The procumbent glasswort, *Salicornia procumbens*, grows in the salt marshes of England. Its root is annual; its stem is trailing, about six inches long, and branched all the way from the base; and its flowers resemble those of the herbaceous species, and bloom in August. This plant possesses the same properties, and is used for the same purposes, as the herbaceous glasswort; and both, though very different on the one hand from the powerfully aromatic rock samphire, and on the other from the marine and cryptogamous fuci, are sometimes called marsh samphire and sea-grass.

The rooting glasswort, *Salicornia radicans*, grows wild on the sea-shores of Britain. Its roots are perennial; its stems are woody, slender, and creeping; the lower parts of the stems, to the extent of about six inches, send out fibrous roots; the upper parts, to the height of 6 or 8 inches, are erect, and send out opposite and crossing branches; and the flowers are produced on short-jointed swollen spikes, and bloom in September.—The shrubby glasswort, *Salicornia fruticosa*, is a small, evergreen undershrub of the sea-shores of Britain, but is of very rare occurrence. Its stem is woody and about a foot high; its branches are numerous, attenuated, and cylindrical; and its flowers grow on small, short, and dense spikes, and bloom in August and September. Both the rooting and the shrubby species share the profusely alkaline properties of the other two native species, and, at the same time, are sufficiently ornamental to deserve a place in the flower-garden. They are readily propagated from either seeds or divisions; but, when grown in ordinary soil, they require it to be impregnated with common salt.

GLASTONBURY THORN,—botanically *Cratægus Oxyacantha Præcox.* A variety of the common hawthorn. It differs nothing from the normal plant of its species, except in earliness of leafing and flowering. It is fabled to have sprung from the staff of Joseph of Arimathea, the noble counseller who buried the body of Christ, and the pretended founder of the abbey of Glastonbury; but it may at best be regarded as having acquired its early habits in the accidental peculiarities of a hawthorn within the Glastonbury grounds. "I have many plants," says Hanbury, "that were originally propagated from this thorn; and they often flower in the winter, but there is no exact time for flowering; for in fine seasons they will sometimes be in blow before Christmas, sometimes they afford their blossoms in February, and sometimes it so happens that they will be out on Christmas day."

GLAUBER'S SALT,—scientifically *Sulphate of Soda.* A very common and useful purging salt. It occurs naturally in many mineral springs, and on a few spots on the surface of the earth; it occurs artificially, and in large quantities, as a residue in the usual chemical processes for obtaining chlorine and making muriatic acid; and it may be intentionally formed, in various ways, by the action of sulphuric acid on soda. It properly consists of 55·55 per cent. of sulphuric acid, and 44·45 of soda; but it takes up so much water of crystallization as to consist, in its usual state, of 24·442 per cent. of sulphuric acid, 19·558 of soda, and 56· of water. Its primary crystals are rhombic octohedrons, but most of its actual ones are four-sided and six-sided prisms. Twelve parts of the crystals dissolve in 100 parts of water at 32° Fahrenheit, 100 parts at 77°, 322 at 91½°, and a less proportion than 322 at any temperature above 91½°. The crystals, when exposed for some time to dry air, gradually and somewhat rapidly lose all their water by efflorescence; so that two ounces of the crystals are not so powerful as one ounce of the effloresced salt.

Sulphate of soda has a saline, cooling, and nauseously bitter taste. It is an excellent purgative for the human subject; but, for many years past, has been seldom prescribed on account of its nauseating bitterness; yet can be rendered somewhat palatable by means of a little cream of tartar or lemon juice; and is a main ingredient in some expensive saline preparations which have enjoyed much popular favour. Some of the epsom salts of the drug shops are, in whole, or in part, badly crystallized Glauber's salt; and some of the expensive Cheltenham salts, formerly in much repute as a patent medicine, were wholly or chiefly a crystallized compound of Glauber's salt and common culinary salt. A pound of crystalline Glauber's salt, or rather less than half a pound of the effloresced salt, forms a good purge for cattle; but this medicine has too diuretic or hydragogic a tendency to be suitable for the horse, and is also so griping as to be less suitable than epsom salt even to cattle.

GLAUCIUM. See Horn Poppy.

GLEANING. The picking up of stray ears and straws of corn on the harvest field, after the crop has been collected by the reapers and gatherers. It is a practice of probably as high an antiquity as the art of reaping; and, in particular, was exemplified in Ruth, who "came and gleaned in the field after the reapers." It has, by popular mistake, been often regarded as a right of the poor, and sometimes abused to a degree almost ruinous to the farmer; and in former as well as recent times, on the Continent of Europe as well as in Britain, it has, within certain limits, been conceded by farmers as a reward or wages of some of the lowest order of their retainers. "When the practice was under proper regulations," says Sir John Sinclair, "it was attended with profit to the industrious poor, without occasioning any particular injury to the occupier. Each farmer, in ancient times, had his particular set of gleaning retainers, who assisted him in the labours of the harvest, and they were indulged with the perquisite of gleaning, after the corn had been gathered. This tended to excite, and to preserve, a mutual attachment between the two classes. But this privilege came to be abused. Persons who had given no assistance to the farmer, nay, who resided in other parishes, presumed to glean, not only among the sheaves, but too often from them, conducting themselves in so disorderly a manner, as to occasion perpetual dispute. The mischief which this gave rise to, was often great, particularly in the common-field system, where the loss incurred has been calculated as high as 30 per cent. To avoid such depredations, the wheat crop was often cut too late, and carried home too quickly, because the farmer dared not trust it in the field, while the poor were perpetually among the sheaves. In several districts it is still the case. The courts of law have decided against any right to gleaning being vested in the poor; but as the practice, under due regulations, tends to promote a friendly intercourse and kindly connexion between the upper and the lower orders of society, it ought not to be given up."

GLEBE. A portion of land attached to an ecclesiastical benefice, for the occupation or advantage of the incumbent. But glebe, in the old sense of the word, denoted soil or ground in general.

GLECHOMA. See Ground Ivy and Alehoof.

GLEDITSCHIA. A genus of ornamental trees, of the cassia division of the leguminous order, named in honour of Gottlieb Gleditsch of Leipsic. In its indigenous state it appears to be confined to North America, China, India, and the Shores of the Caspian; and it comprises nearly a dozen distinct species. One of these, the three-thorned acacia, *G. triacanthos*, in favourable situations, attains a height of 70 or 80 feet, with a trunk of 3 or 4 feet in diameter, and clear of branches to the height of 30 feet. It was first cultivated in Britain in 1700. It is a highly ornamental tree, with a delicate, light green, pinnate-leaved foliage, and of gracefully varied form. The *G. monosperma*, or one-seeded Gleditschia, was introduced into Britain in 1723, and has attained a height of more than 80 feet at Syon near London. Most of the other species have naturally a height of about 25 feet; and all, with the exception of *G. sinensis*, are deciduous.

GLEICHENIA. A genus of beautiful cryptogamous plants, constituting the type of the tribe Gleicheniew—one of the five tribes of the order of ferns. About 100 species of this tribe, all exotics, are known to botanists; and about one-fifth of these, belonging to four genera, have been introduced to Britain, and are treated—particularly those of the snake's-tongue genus—as fine ornaments of our plant-rooms and hot-houses.

GLEN. A narrow vale or river-basin between mountains or lofty hills.

GLOBBA. A genus of ornamental, perennial-rooted, herbaceous, tropical plants, of the ginger family. Eight or nine species, principally yellow-flowered and from 12 to 24 inches in height, and the greater number from India, have been introduced to British collections.

GLOBE AMARANTH,—botanically *Gomphrena*. A diversified genus of tropical plants of the amaranth order. One annual species, three biennials, one evergreen herb, and two evergreen under-shrubs, have been introduced to Britain; and about 20 other species are known. The introduced annual is by far the best known, and has been cultivated in our hothouses during about 130 years, and is described as follows by Miller: "It rises with an upright branching stalk about 2 feet high, garnished with spear-shaped leaves, placed opposite. The branches also come out opposite, and the footstalks of the flowers, which are long and naked, with two short leaves, close under each head of flowers. The heads at their first appearance are globular, but as they increase in size, become oval; these are composed of dry scaly leaves placed in imbrication like the scales of fish; under each of these is situated a tubulous flower which just peeps out of the covering; but these are not so much regarded by the generality of people, for the scaly empalement which covers them is so beautiful, and these, if gathered before they are too much faded, will retain their beauty several years. After the flowers are past, the germen which is situated in the bottom of each, becomes a large oval seed, enclosed in a chaffy covering, which ripens late in autumn, and the plant decays soon after. There are two varieties of this sort, one with fine bright purple, the other with white or silvery heads; and these never alter from seeds, so that they are permanent varieties, though in other respects they do not differ." Two permanent varieties, larger in plant and smaller in flower than the East Indian varieties, also grow wild in the West Indies.

GLOBE FLOWER,—botanically *Trollius*. A genus of hardy, ornamental, perennial-rooted, herbaceous plants, of the ranunculus tribe. The European species, *Trollius Europæus*, grows wild in the woods of Britain. Its root is fibrous, tufted, and black; its stem is smooth, hollow, and about 20 inches high, and branches toward the top; its leaves are deeply cut into lobes or segments, and resemble in appearance the leaves of aconite; and its flowers are produced singly at the ends of the branches, and have a bright yellow colour and a globose form, as if they were globular ranunculuses, and bloom in May and June. This plant has long been cultivated in gardens for the sake of its flowers, and is fond of moisture and somewhat free exposure to the sun; and may easily be propagated by the dividing of the roots in the latter part of September. It is regarded by the peasantry of Sweden, Scotland, and some parts of the north of England, as a festal plant; and its flowers are gathered for the temporary decoration of windows, doors, and rooms. A dwarf variety of it, *T. e. humilis*, about a foot in height, was introduced nearly half a century ago from Austria; and a whitish-flowered variety, *T. e. albus*, also about a foot in height, seems to have originated in the course of British garden culture. Three yellow-flowered species, and two orange-flowered species, all smaller plants than our normal indigenous one, have been introduced from the temperate parts of the old world; and one of these, the Asiatic or Siberian, comprises several varieties.

GLOBE-THISTLE,—botanically *Echinops*. A genus of coarsely ornamental, hardy, herbaceous plants, of the thistle division of the composite order. A subdivision of the thistle suborder, comprising 13 genera, takes the globe-thistle as its type, and is called Echinopsideæ. Nearly twenty species of globe-thistle, all exotics, and principally from Continental Europe and Asiatic Russia, occur in our collections; and two of these, the round-headed and the Ritso, both perennial-rooted, have long been somewhat common in gardens. The species vary in height from about 20 inches to about 7 feet; and, though totally destitute of delicacy and of powerful thistle-like appearance, they are generally esteemed as very desirable ornaments. The most common one is described as follows, under the exploded name of *Echinops major*, by Miller: "It grows naturally in Italy and Spain; it hath a perennial root, from which arise many stalks that grow to the height of four or five feet; these are garnished with long jagged leaves, divided into many segments almost to the mid-rib, the jags ending in spines; they are of a dark green on their upper side, but woolly on their under; the flowers collected in globular heads, several of these grow upon each stalk; the common hath blue flowers, but there is a variety of it with white. It flowers in July, and the seeds ripen in August. This plant is easily propagated by seeds, which, if permitted to scatter, the plants will rise in plenty, so a few of them may be transplanted to the places where they are designed to remain to flower; they require no other culture, but to keep them clean from weeds; the second year they will flower and produce seeds, and the roots will continue two or three years after; but if the seeds scatter, the plants will become troublesome weeds; to prevent which, the heads should be cut off as soon as the seeds are ripe." The botanical name Echinops alludes to the hedgehog-like appearance of the heads of flowers.

GLOBULARIA. A genus of very beautifully-flowering plants, constituting of itself the natural order Globulariæ, Globularinæ, or Globulariaceæ. The species are nearly allied to those of the teasel and the aster tribes, but are readily distinguishable from them by their superior ovary. They comprise both evergreen herbs and evergreen shrubs; they naturally possess alpine or mountain-loving habits; and they are distributed throughout the most genial regions of the northern hemisphere from Madeira to Germany. Nine or ten species have been introduced to British gardens; and several more are known. Most possess bitter, tonic, and aperient properties; and the leaves of *G. alypum*, in particular, are exceedingly bitter and powerfully purgative.

The common species, *G. vulgaris*, is sometimes called the blue daisy, grows wild and in abundance around Mountpelier, at the foot of the Jura mountains, and in many parts of Italy and Germany, and was introduced about two centuries ago to the gardens of Britain. It is a small, hardy, evergreen herb; its leaves are very like those of the daisy, but thicker and smoother; and its flowers grow on footstalks about six inches high, and consist of several florets, and have a globular form, and a fine blue colour, and bloom in May and June.—The heart-leaved species, *G. cordifolia*, is also a small, hardy, blue-flowered, evergreen herb; and was introduced upwards of two centuries ago from Germany. It prefers a light soil, and is propagable from either seeds, cuttings, or root-divisions. — The dwarf, the naked-stalked, the flax-leaved, and the daisy-leaved, the last with red flowers, and the other three with blue flowers, are akin to the common and the heart-leaved species in both form and habit. But the long-leaved, the alypum, and the spinous species, the last an herbaceous evergreen with blue flowers, and the other two undershrubby evergreens with respectively white and pale flowers, are greenhouse plants, and require a compost soil of peat and loam.

GLOBULEA. A genus of ornamental Cape-of-Good-Hope plants, of the crassula tribe. Nearly 20 species have been introduced to British greenhouses; and a considerable number more are known. The introduced species vary in height from 2 or 3 to about 15 inches; most are white-flowered; all are evergreen; and about one half are herbaceous, and the remainder ligneous.

GLORIOSA. A genus of beautiful, bulbous-rooted, tender plants, of the tulip family. The superb species, sometimes called the superb lily of Ceylon, or simply the superb lily, *Gloriosa superba*, is a native of Ceylon, and of the Malabar coast, and was introduced to Britain toward the close of the 17th century. Its root is fleshy, oblong, whitish, and nauseously bitter; its stem attains a height of from 6 to 10 feet, but requires support to prevent it from trailing on the ground; its leaves grow alternately on the stem, and are smooth and about 8 inches long, and decrease from a breadth of 1½ inch till they pointedly terminate in a tendril which clings for support to any neighbouring plant; and the flower is produced from the upper part of the stem, and stands on a slender footstalk, and blooms from the latter part of June till August. "It is composed of six oblong petals, ending with acute points, which, on their first opening, are of an herbaceous colour, and spread wide open; the flower hanging downward as the crown imperial and fritillary, but afterwards the petals turn quite back, and change to a very beautiful red flame colour, their acute points meeting at the top; these petals are finely waved on their edges. The six stamina spread out every way almost horizontal, and are terminated by prostrate summits. In the centre of the flower is situated a roundish germen, supporting an inclining style, crowned by a triple stigma." The bulb should be potted in the end of February or beginning of March, in a fresh compost of equal parts of loam, sand, and leaf mould, and a double part of turf; and when the plant is 2 or 3 feet high, it should be repotted in a compost of the same kind with the addition of one part of well-rotted cow-dung.—Three species, all very much smaller than the preceding, have been introduced from respectively Senegal, Mozambique, and Nepaul.

GLORY-PEA, or GLORY-FLOWER,—botanically *Clianthus*. A recently discovered genus of ornamental plants of the leguminous order. The crimson glory-pea, *Clianthus puniceus*, is a native of the northern island of New Zealand and was originally discovered by Sir Joseph Banks and Dr. Solander, but found its way into Britain by means of seed sent by a missionary catechist in New Zealand to a clergyman of the Isle of Wight. It first bloomed in the clergyman's garden in 1833; and it has since become generally known in the proudest gardens of the kingdom as one of the most exquisite flowering-shrubs of either the shrubbery, the wall, or the conservatory. It is a ligneous evergreen; and, besides being eminently beautiful in at once form, foliage, and flowers, it readily adapts itself to very wide diversities of cultivation and training. Its stem is naturally procumbent and about 3 or 4 feet high, but can be trained either erectly in the manner of a standard, or spreadingly in the manner of a large expansive wall-plant; its branches are cylindrical, glabrous, glossy green, and slightly pubescent; its leaves are 3 or 4 inches long and unequally pinnate, each consisting of 8 or 10 pairs of leaflets; its leaflets are alternate or opposite, oblong-elliptical, retuse, green and glabrous above, and palish-green below; and its flowers are produced in simple, axillary, pendant racemes, and have each a rich carmine-coloured corolla of two inches in length, and bloom in May and June. The plant is hardy, and thrives well in a soil of equal parts of loam and peat, and can easily be propagated from either seeds or cuttings. Many magnificent specimens of it have been raised in Britain; and so early as 1840, one specimen of it, which had been planted in the spring of 1838, covered a portion of a south-east wall 9 feet high and 14 feet broad, and produced thousands of its superb racemes. The botanical name Clianthus is literally translated in the popular name glory-flower.

GLORY-TREE. See CLERODENDRON.

GLOSS-ANTHRAX. See BLAIN.

GLOSSODIA. A small genus of very beautiful, tuberous-rooted, Australian plants, of the orchis family. Two blue-flowered species have been introduced to British collections. The name glossodia alludes to a tongue-like appendage in the interior of the flower.

GLOW-WORM. This is the female of one of the species of *lampyris*. The light is most frequently observable early in the summer, when the animal is in motion. It can be withdrawn or displayed, at pleasure, by contracting or unfolding the body. When crushed in the hand, this luminous substance adheres to it, and continues to shine till it dries. This extraordinary provision of nature is for the purpose of attracting the male. The glow-worm is apterous, or without wings. The male possesses elytra which cover wings longer than the body. The head and antennæ are black, the former concealed by the broad plate of the thorax. The four last rings of the abdomen, which emit the light, are not so bright in the male as in the female, and are nearly destitute of that luminous quality which renders her so remarkable.

GLOXINIA. A genus of superbly-flowering tropical plants, of the gesneria family. All its species are low-growing herbaceous evergreens, very similar in the appearance of the plants to gesnerias, but much more massive in the bulk, elegant in the form, and delicate in the tinting of their tubulous flowers. Three purple-flowered species, *G. maculata*, *G. speciosa*, and *G. caulescens*, were brought from tropical South America, in respectively 1739, 1815, and 1826; a blue-flowered species, *G. hirsuta*, in 1824; and a red-flowered species, *G. rubra*, in 1840.—But the showy species, *G. speciosa*, comprises a number of permanent varieties, with different shades of colour in the flower, and, when raised from seed in any ordinary hot-house sowing, it very frequently produces some plants with purple flowers, some with white flowers, and some with various tints and colours intermediate between purple and white. Some of the oldest of its chief permanent varieties are *G. s. alba*, with white flowers, *G. s. maxima*, purple and white, *G. s. menziesii*, blue and white, *G. s. violacea*, violet coloured, and *G. s. pallida*, pale blue.—The red-flowered species, *G. rubra*, has become a greater favourite than even the showy; and, very soon after it became known, it began to originate very many most beautiful hybrids. The flower of the normal plant, when first expanding, has a deep, rich, blood-red colour, with a much darker tint combined with a slight shade of brown in the throat; and after being for some time open, it assumes a paler hue, with a prevalence of beautiful crimson, but the lower part of the throat evolving a tinge of blue, while the upper part retains its original intense colour. The principle hybrids of this species in one year, the year 1844, were the magnificent, the remarkable, the two-coloured, and Carton's; and these were raised, along with many others, from seeds of the red-flowering gloxinia fertilized with *Sinningia guttata*. The flower of the magnificent hybrid, *G. r. magnifica*, has a pinkish flesh colour, with a pink tube and white throat; and the plant is strong and has an erect habit of growth. The flower of the remarkable hybrid, *G. r. insignis*, has a pink tube, with spreading and nearly white segments or limb, the upper portion shaded with the colour of the tube, and the throat tinged with blue. The flower of the two-coloured hybrid, *G. r. bicolor*, has a deep bluish purple colour, with a whitish throat, and with an edging of white on the upper part of the limb. The flower of Carton's hybrid, *G. r. Cartoni*, is large, full flowered, and of good substance, with the throat and the margin white, and with the other parts of a deep pink, and increasing in intensity near the mouth of the tube.—Gloxinias may be readily raised, not only from seed, but from any cuttings of a leaf which are allowed to retain a portion of the midrib. Plants should be shaken up and potted in February, and repotted when their roots appear through the bottom of the first pots; and, if after this treatment, they be plunged in a bark bed, and surrounded with moss on which the leaves can rest, they will begin to bloom profusely in April, and will possess comparatively great brilliance of colour. Few floral objects are more superb or exquisitely beautiful than a number of gloxinias growing in a bed of roots and moss.

GLUCINA. A rare metallic oxide, discovered in 1798, but hitherto known to exist only in beryl, emerald, and euclase. It constitutes about 14 per cent. of beryl, and exists there in combination with silica and alumina. It is, in itself, a white, tasteless, odourless powder, insoluble in water, and three times heavier than water. The metallic basis of it is called glucinium, and ranks as one of the simple or elementary bodies known to chemists.

GLUE. A tenacious cement, principally used by cabinet-makers, joiners, book-binders, case-makers, and hatters. The substances from which glue is made, are the shreds or parings of hides; the ears before they are immersed in the tanner's vats; the cuttings and raspings of horn, from the comb-maker, the button-maker, and the horn lanthorn-maker; the hoofs and horns of oxen, calves, and sheep from the butcher; the pelts of the hare, rabbit, beaver, &c. from the hat makers, beaver-cutters, and furriers; and the parings of vellum and parchment from the white leather dresser, glover, &c. These substances are indiscriminately mixed together, and are purified from all grease and dirt by digestion in lime water, the greatest care being taken to remove every piece that is in the slightest degree putrescent. The materials are next steeped and washed in clean water, with frequent stirring, and are afterwards laid in heaps, and the water pressed out. They are then boiled in a large brass kettle with clear water, the fat and dirt being constantly skimmed off as they rise, and when the whole is dissolved, a little melted alum or finely powdered lime is added. After the skimming has been continued for some time, the whole is strained through baskets, and suffered to settle, in order that the remaining impurities may subside, and the fat rise to the top. The impurities and fat being removed, it is then returned into a clean kettle, and suffers a second evaporation and skimming. When it acquires a clear darkish brown colour, and a sufficient consistence which is known by the appearances during ebullition, it is lifted out by a scoop, into frames or moulds, about six feet long, one foot broad, and two deep, where it is allowed to cool gradually. It is then cut by a spade into square cakes, and each of these is afterwards divided into three pieces, by an instrument like a bow, having a brass wire for its string. The pieces thus cut are dried in the open air, on a kind of net-work, (generally old herring nets,) fastened in moveable sheds of four feet square, each containing six or eight rows of net work. When the glue is dry, each piece is rubbed gently with a wet cloth, to give it that glazed appearance which the London glue always possesses. The different pieces are then packed carefully up in separate rows in barrels or hogsheads and are ready for sale. The best glue swells considerably, without melting, by three or four days immersion in cold water, and recovers its dimensions and properties by drying. When glue looks thick and black, or has got frost in the drying, it should be melted over again with a sufficient quantity of fresh glue. Good glue is distinguished by its having a strong black colour, and by being free of cloudy and black spots, when held between the eye and the light.

GLUE MANURE. The fertilizing refuse of the glue manufactories. The gelatinous matter which constitutes animal jelly would fertilize soil; but is all carefully used up for glue, and does not form any appreciable portion of the glue-maker's refuse. See the articles Gelatine and Glue. What is meant by glue-manure is the residuum of animal matter, and particularly of bones, after the gelatine is extracted. "In the manufactories of glue," says Liebig, "many hundred tons of a solution of phosphates in muriatic acid are yearly thrown away as being useless. It would be important to ascertain how far this solution might be substituted for bones. The free acid would combine with the alkalies in the soil, especially with lime; and a soluble salt would thus be produced, which is known to possess a favourable action on the growth of plants. This salt, muriate of lime or chloride of calcium, is one of those compounds which attract water from the atmosphere with great avidity, and retain it when absorbed; and, being present in the soil, it would decompose the carbonate of ammonia, existing in rain-water, with the formation of sal-ammoniac and carbonate of lime. A solution of bones in muriatic acid placed on land in autumn or in winter, would therefore not only restore a necessary constituent of the soil, but would also give to it the power of retaining all the ammonia falling upon it in the rain for a period of six months." See the articles Bone-Manure, Phosphate, Chlorine, Muriate, Ammonia, and Lime.

GLUTEN. A vegetable compound procured by repeatedly washing wheat flour in a large quantity of water, by which means the starch is dissolved, leaving the gluten behind in a very tenacious, ductile, somewhat elastic state, and possessed of a brownish grey colour. It has scarcely any taste, and is insoluble in water, alcohol and ether, but is taken up by acids and alkalies. The acid solution is precipitated by an alkali, and, reciprocally, the alkaline solution by an acid. Dried by a gentle heat, it contracts its volume, and becomes hard and brittle. Its products with fire, or nitric acid, are nearly the same as those of gum and sugar. Gluten is present in most kinds of grain, such as wheat, barley, rye, oats, pease and beans; but the first contains it in far the largest proportion, which is the reason that wheaten bread is more nutritious than that made with other kinds of flour; for, of all vegetable substances, gluten appears to be the most nutritive. It is to the presence of gluten, that wheat flour owes its property of forming a tenacious paste with water, to which cause is due the formation of light spongy bread. The carbonic acid, which is disengaged during the fermentation of the dough, being detained by the viscid gluten, distends the whole mass, and thus produces the rising of the bread. Good wheat flour contains from 19 to 24 per cent. of gluten. The wheat of warm climates is richer in gluten than that of colder regions. Gluten consists of two distinct principles; to one of which has been applied the name of *gliadine*, and to the other that of *zymome*. To obtain these principles, the gluten is boiled repeatedly in alcohol, which dissolves the gliadine and leaves the zymome in a pure state. On mixing the powder of guaiacum with the latter substance, a beautiful blue colour instantly appears; and the same phenomenon ensues, though less rapidly, when it is kneaded with gluten, or the flour of good wheat moistened with water. With bad flour, the gluten of which has suffered decomposition, the blue tint is scarcely visible. The intensity of the colour thus produced is entirely dependent on the relative quantity of zymome contained in the flour; and, since the quantity of zymome is proportional to the quantity of gluten, the proportion of the latter, and therefore the quality of the flour, is tested by the action of the guaiacum.

GLYCERIA. A small genus of indigenous, perennial, aquatic grasses, constituting the type of the tribe or suborder Glycerinæ. This tribe comprises the genera poa, bromus, hydrochloa, schedonorus, briza, catabrosa, eragrostis, glyceria, and four others. The genus glyceria consists of two species, which the older botanists included in the genera festuca and poa; and it is characterized by its blunt and many-toothed lower paleæ, by its unequal glumes, and by its slender and elongated spikelets.

The floating glyceria, or floating sweet-meadow-grass, *Glyceria fluitans*, formerly called botanically *Festuca fluitans* and popularly floating fescue, grows wild on almost all alluvial marshes or wet meadows, and by the sides of ditches, pools, and streams. Its root is fibrous; its stem is about two feet high, and is decumbent in the lower part, oblique in the middle part, and erect in the upper part; its leaves are broad and long, and float when the plant grows in a sufficient depth of water; its panicle is long, slender, and nodding, and is somewhat branched at the base; and its spikelets are very slender, and have each from 7 to 9 florets. This grass, though very fond of an abundant and constant supply of water, is admirably adapted for all ordinary irrigated meadows, and will yield a considerable produce even on common undrained farm ground; and it is greedily eaten by horses, cattle, sheep, and swine, and constitutes, in most respects, highly valuable forage. Its seeds, also, form a common and enriching food of several species of economical, fresh-water fish, and of various species of the most esteemed aquatic fowls; and, when gathered and dried, they constitute the manna-croup of the shops, and are extensively used as an agreeable and highly nutritious material for soups and gruels. They ripen irregularly, and are readily shaken out when ripe, so that they are not easily collected; and in Poland and Germany, they are gathered in a similar manner to the juniper berries of Britain, by the shaking or beating of the ripening plants, every second or third day, over a cloth spread under the panicles.—A bad variety of this species is in use, of a dwarfish habit, with comparatively short panicles and seeds, and not so well adapted as the normal plant to half-dry soils.

The water glyceria, or reed meadow-grass, or water sweet meadow-grass, *Glyceria aquatica*, called by the old botanists *Poa aquatica*, and by Hartig *Hydrochloa aquatica*, grows wild on the richly alluvial flooded banks, and within the richly alluvial margins of streams and pools; it specially abounds on low banks which are statedly overflown by the fresh back water dammed up by tides; and, in common with some other aquatic herbage, it makes a conspicuous figure, for both good and evil, in the husbandry of the English fens. Its root is powerfully creeping; its stem is erect, cylindrical, and usually about 6 feet high; its leaves are broad, long, tapering, and vivid green; its panicle is erect, equally spreading, and freely branched; its spikelets are elongated, and contain each about 7 or 9 florets; and its seeds are short, compact, and seven-ribbed. "This," says Curtis, "is one of the tallest of British grasses, with a powerful creeping root; a native of most parts of Europe, and very common in the fens of Cambridgeshire and Lincolnshire, where it not only affords rich pasturage in summer, but forms the chief winter fodder. It is sometimes cut thrice in one season. It grows not only in very moist ground, but in deep water; and, with cat's-tail, burr-reed, &c., soon fills up ditches, and occasions them to require frequent cleansing. In this respect, it is a formidable plant even in slow rivers. In the Island of Ely, they cleanse these by an instrument called a bear, which is an iron roller with a number of pieces of iron like small spades fixed to it; this is drawn up and down the river by horses walking along the bank, and tears up the plants by the roots which float, and are carried down the stream."—Two other species ranked by Sir J. E. Smith as glycerias, may be regarded as now a part of the genus hydrochloa. See the article Hydrochloa.

GLYCINE. A genus of ornamental plants, of the lotus division of the leguminous order. It is sometimes popularly called liquorice vetch or wild liquorice. Ten or twelve species, all tender, and mostly evergreen twiners, occur in British collections; and about a dozen other species are known. But a large number of species of the kidney-bean division of the leguminous order were formerly included in the genus glycine; and though these are now distributed among nine or ten other genera, a few of the hardy and more common ones will probably continue for a long time to be better known by their old botanical name than by their new ones, and may here be appropriately noticed..

The frutescent species or Carolina kidney-bean, *Glycine frutescens*, called by Nuttall *Wistaria frutescens*, and by Pursh *Apios frutescens*, is a hardy deciduous twiner of Carolina and Virginia, and was introduced to Britain about the middle of the first half of last century. Its stem is usually about 10 or 12 feet high, but it rises, not by means of claspers, but by means of the twining habit of its branches; and it either ascends any tree in its immediate neighbourhood, or trails along the ground till it reaches trees at the distance of a considerable number of feet, and even then ascends them to a considerable height; its leaves are large, pinnated, and imposing, and closely resemble those of liquorice; its folioles are arranged in about three pairs and an odd one to each leaf, and have a lightish hoary colour, with a bluish tint; and its flowers grow from the wings of the leaves, and have a bluish purple colour, and are very large and ornamental, and usually bloom from June till September.

The tuberous-rooted species or ash-leaved milk-vetch, *Glycine Apios*, called by Boerhaave *Apios tuberosa*, is a native of Virginia, and was introduced to Britain upwards of two centuries ago. Its roots comprise many knobs, which increase in number as long as they are allowed to be undisturbed, and possess the requisite conditions of soil for spreading; its stem twines to the height of from 6 to 12 feet according to the comparative richness of the soil, but dies down to the crown of the roots in autumn; its leaves resemble those of the ash-tree both in their pinnate form and in their general appearance; and its flowers grow in small spikes from the sides of the twining stems, and have a reddish colour, and bloom in August and September.

The monœcious species, *Glycine monoica*, called by Elliot *Amphicarpa monoica*, is a native of moist shady places in Virginia, and was introduced to Britain in the latter part of last century. Its stems are hairy, and twine upward to a height of from four to six feet; its leaves are trifoliate and naked; its flowers are produced in pendulous bunches from the sides of the stems, and have a pale violet standard and white keel and wings, and are very beautiful and imposing, and bloom in June and July; and its pods are compressed and half-rounded, and hang by lengthened peduncles, and frequently mature their seeds in September.—The fruit of at least two species of glycine is much prized among the Hindoos as a common and pleasant article of diet.

GLYCOSINIS. A small genus of beautiful, odoriferous, white-flowered, evergreen, small, tropical trees, of the orange-tree family. Two species, each naturally attaining a height of about 20 feet, were added, about half a century ago, to the hothouse collections of Britain.

GLYCYRRHIZA. See Liquorice.

GLYSTER, or Clyster. An enema or medicinal liquid injected into the anal orifice of an animal, with the design of operating on the lower intestines. It is much and very usefully employed on the human subject; but though equally well adapted to the lower animals, it has been very generally neglected in the case of even horses and cattle. An aperient glyster, in all veterinary practice, is highly serviceable in the first stages of fever, or in inflammation of the bowels, or in an irritated state of the bowels, or in obstinate costiveness, or for assisting the action of internally administered purgatives; an anodyne glyster is serviceable in cases of great irritation of the lower intestines, of obstinate diarrhœa, or of excessive purging from the internal administration of cathartics; a nutritive glyster is valuable in cases of epidemic catarrh, of locked-jaw, of convulsions, or of extreme debility accompanied with want of appetite; and a cathartic glyster is of use in cases where the lower intestines are obstructed and require to be speedily evacuated.

An aperient glyster for a horse may consist simply of a gallon of warm water, or of two ounces of common soap dissolved in a gallon of warm water, or of a pint of linseed oil and nearly a gallon of warm water,—though this last is appropriate chiefly for the purpose of expelling the entozoa which infest the rectum; a cathartic glyster for a horse may consist of half a pound of common salt or of Epsom salts dissolved in a gallon of warm water, or of an ounce or an ounce and a half of aloes dissolved in two or three quarts of warm water; an anodyne clyster, for a horse, may consist of 1½ or 2 quarts of very fine gruel, or of 1½ or 2 quarts of thin mucilage of starch or arrowroot, or of 4 ounces of finely powdered prepared chalk well stirred into 1½ or 2 quarts of gruel, with the addition, in very bad cases, of two scruples or a drachm of powdered opium; and a nutritive glyster for a horse ought never to consist of strong broths or ales or wines or any other stimulating substances, but ought to consist only of thick gruel, and to be administered in quantities of not more than a quart at a time. Proper glysters for cattle are strictly analogous to these for horses.

The temperature of every glyster, at the moment of administering it, ought to be, as nearly as possible, about 96° of Fahrenheit. The old glyster instrument was simply a very large bladder tightly attached to a tube of wood or of polished pewter, about a foot in length and half an inch in the width of the bore; and this may still be properly enough used; but a far preferable instrument is the patent glyster-pump of Mr. Read. "The principal art of administering a glyster," Mr. Youatt tells us, "consists in not frightening the horse. The pipe, well oiled, should be very gently introduced, and the fluid not too hastily thrown into the intestines."—*White.—Blaine.—Thomson.—Turton.—Youatt.—Clater.—Bartlet.*

GMELINA. A genus of ornamental, evergreen, tropical, tall shrubs, of the verbena tribe. Five species, varying in natural height from 10 to 18 feet, have been introduced to British hot-house collections. The root of one of these species, *G. asiatica*, possesses mucilaginous and demulcent properties, and is prescribed by the Hindoo physicians as a medicament for purifying the blood.

GNAPHALIUM. A diversified genus of plants, of the thistle division of the composite order. A multitude of species formerly included in it are assigned by modern botanists to six or seven other genera; and 12 or 13 species now included in it formerly belonged to the Linnæan genus Filago. The gnaphalium genus has suffered enormously by the change; for it has resigned to the new genera, particularly to helichrysum and astelma, numerous species of great beauty,—species which not only impart splendour to the greenhouse, but contribute their flowers to the adorning of rooms and windows during the chilly months when other floral beauties are rare; and it has obtained from the filagos only species of very coarse and uninteresting appearance. The genus, as now constituted, comprises 7 broad-leaved or true gnaphalium species, and nearly 20 narrow-leaved or filago-like species; and 8 of its species are indigenous, while only 4, and all these exotic, have any pretensions to an ornamental character. All the gnaphaliums, whether in the old or in the new sense, belong to the class of plants popularly called everlastings. See the article EVERLASTING.

The German species, or common cudweed, *Gnaphalium germanicum*, called by Linnæus *Filago germanica*, is an annual weed of multitudes of sandy pastures, light grass fields, and gravelly waste grounds throughout England and Scotland. Its stem is erect, slender, whitish, and from 9 to 18 inches high; its leaves are small, oblong, pointed, and whitish, and thickly cover the stem; and its flowers grow at the top and at the divisions of the stem, and have a yellow or yellowish-brown colour, and bloom from June till August. The whole plant has a hoary or cottony appearance. Its young flowers rise above its old ones, and have occasioned it to be sometimes called the herb impious. A decoction of it is popularly regarded as a remedy for quinsies and some other complaints; and the presence of the dried plant among clothes is supposed to prevent the breeding of moths.—The wood species, *G. sylvaticum*, called by Willdenow *Filago sylvatica*, is a perennial-rooted native of mountainous shady places in England and Scotland, with yellowish-brown or brownish-yellow flowers, and a stem about 15 inches high, and blooming in August.—The upright species, *G. rectum*, or *Filago recta*, is very similar to the wood species, but inhabits lower situations, and loves very light soils.—The supine or alpine species, *G. supinum* or *G. alpinum*, is a very low perennial-rooted native of the Scottish mountains, with a stem only 3 or 4 inches high, and carrying yellowish-brown flowers in June and July.—The least species, *G. minimum*, called by some botanists *Filago alpestris*, is a still lower annual than the preceding, and inhabits the light pastures of England and Scotland, and carries yellow flowers in July and August.—The marsh species, *G. uliginosum*, or *G. multicaule*, is an aquatic annual of Britain, with stems about a foot high, and carrying yellow flowers in August.—The French species, *G. gallicum* or *Filago gallica*, is a brownish-yellow flowered annual, 8 or 10 inches high, inhabiting sandy grounds, and blooming from June till August.—The yellowish-white species, *G. luteo-album*, is an annual weed of sandy grounds in England, with stems about two feet high, and carrying yellowish-white flowers in July and August.—All these indigenous species, except the yellowish-white, belong to the Filago division of the genus.

GNAT. These well known and troublesome insects are distinguished by having the body and feet very long and downy, antennæ garnished with hairs; large eyes; a proboscis composed of a membranous cylindrical tube, terminated by two lips, forming a little button, and sucker formed of five scaly filaments, producing the effect of a needle; The wings are placed horizontally over each other. When they bite, the sucker is plunged through the skin, and, as it buries itself, the sheath or trunk is drawn up towards the breast. The pain of the wound is occasioned by a venomous fluid which they inject into it; the best remedy for which is the preparations of ammonia. It is a curious fact, that it is only the females which thus torment us. One species of these insects is known under the name of *mosquitoes*, against whose attacks various means have been resorted to in different countries, as curtains of gauze, and various essential oils; the latter of which appear to be only partially successful. The Laplanders drive them off by means of smoke, and anointing their bodies with grease. These insects also feed on the juice of plants. The female deposits her eggs on the surface of the water, in a long mass. In their larva state, these animals are aquatic during the greater part of the summer. All stagnant waters are full of these small worms, hanging with their heads downwards, whilst their hinder parts reach the surface of the water. In this state the stigmata, or organs of respiration, are placed in the posterior part of the body: they are also, in this condition of existence, provided with small fins. After having remained in the larva state for about twenty days, they are transformed into chrysalids, in which all the limbs of the perfect insect are distinguishable, through the diaphanous robe with which they are then shrouded. After remaining three or four days wrapped up in this manner, they become gnats, and ascend into a new element. No sooner does the chrysalis reach the surface of the water, than the insect with its head bursts the shell, which then serves it for a boat, of which its wings are the sails. If in this critical moment a breeze arises, it proves a dreadful hurricane to these pigmy sailors; for it oversets the little bark, and the insect, not being yet disengaged from it, suffers a fatal shipwreck. If, however, the weather prove calm, the gnat makes a more prosperous voyage. Having time to dry his wings, before leaving the boat, he is enabled to mount into the air, where, contemptible as he may seem, he soon becomes the inveterate tormentor of the lords of the creation.

GNEISS. A metamorphic or non-fossiliferous stratified rock, of the same mineral composition as granite. It constitutes a large proportion of the mountains of the Scottish Highlands, and of the entire mass of the islands of the Hebrides; it gives many of the mountains and the islands which consist of it a lumpish, tame, and sterile appearance; and, in many instances, it has sullenly and stubbornly resisted the agencies of disintegration, and is covered with both a very thin and a very poor soil, and can boast but a comparatively small proportion of verdure. It generally consists of quartz, felspar, and mica; but it sometimes wants mica, sometimes possesses hornblende, and occasionally exhibits a considerable complexity of constitution. The strata and beds of it differ widely in thickness, are often waved, contorted, and variously disarranged, and, in a few instances, are remarkably interwoven and dissevered with veins of granite. Its antiquity, in a geological view, is a subject of dispute, and can be conjectured mainly from the presence of pieces of clayslate, limestone, and other newer rocks, and is probably very various.

GNIDIA. A genus of ornamental, evergreen, yellow-flowered, Cape-of-Good-Hope shrubs, of the wild olive tribe. Nearly twenty species have been introduced to the greenhouses and conservatories of Britain; and several more are known. Most have a height of from 12 to 30 inches; and several, particularly *G. simplex*, *G. imberbis*, *G. imbricata*, *G. oppositifolia*, and *G. sericea*, possess a comparatively high degree of beauty. The name gnidia is the ancient appellation of the laurel.

GNIDIUM. See DAPHNE.

GOAD. A pointed instrument formerly used, especially in the East, for driving oxen.

GOAR-VETCHES. Summer vetches. See the article VETCH.

GOAT,—scientifically *Capra*. A genus of quadrupeds, of the order Ruminantia. It is nearly allied to the genus of antelopes on the one hand, and to the genus of sheep on the other; and constitutes the type of a tribe comprising three genera, bearing the name of Capridæ, occupying the nearest place to the deer tribe, and capable, under an enlarged classification, of being placed in one group with the ox tribe. The antelopes, including the true antelopes, the gazelles, the blessbok, the mhorr, the springbuck, the pallah, the reedbuck, the kleenbok, the chamois, the prongbuck, the cambing-outan, the nyl-ghau, the koba, the addax, the blaubok, the abu-harb, the canna, the oryx, the gnu, the koodoo, the bekr-el-wash, and others, are by far the most numerous and diversified section of the Capridæ, and present thousands of interesting points of observation to the student of wisdom and beneficence and beauty in the works of the Creator; but the goats and the sheep make the nearest approach to the eminently useful ox tribe, and come within the limits of domestication and direct utility to man, and, though far inferior to the antelopes in the number of species, greatly excel them in the far more interesting department of provincial varieties and domestic breeds. The Capridæ, as a whole, possess great elegance of form, much swiftness of motion, and eminent gentleness of disposition; and are distinguished from the deer tribe, principally by the form and persistence of their horns. The inner portion or body of their horns is a prolongation of the bone of the skull, very cellular in texture, and nourished from the root by means of appropriate vessels and nerves; and the outer portion consists of horn, envelopes the inner portion in the manner of a sheath, and is also nourished from the root. The horns, except in one species, never branch or protuberate into anthers; and in some species, they are somewhat flattened,—in others, they are abruptly kneed or hooked,—in most, they are rounded or spirally twisted,—and in almost all, they have a backward inclination.

The genus Capra is characterized by Cuvier as follows: "The direction of the horns is upwards, bending to the rear, more or less angular, compressed, nodose, and transversely wrinkled; they are common to both sexes, but smaller, less angular, and straighter in the females; the line of the forehead and chaffron is rather convex; the eye of a light brown or yellowish colour, with a lengthened dark pupil, has a lively and independent expression; there is no suborbital or lachrymary opening beneath the eye: the nose is without a muzzle, leaving only a narrow naked space between the nostrils; a beard adorns the chin of nearly all the males; the ears are narrow and rather rounded at the tips; the tail is short, naked below, often carried in an elevated position, and the fur is not very course, but of different lengths and colours, and accompanied beneath by a close woolly down; the legs are strong and thick, with a small callosity on the carpus instead of a brush; the hoofs are high and solid, supporting rigid perpendicular pasterns. The females are furnished with two mammæ, forming an udder; they become capable of propagating at seven months old; they spend five months in gestation; and they usually produce two kids at a birth. The other sex does not develope his faculties till he becomes a year old,—and retains them in full power during only five years, or till less than one-half of the average period of the goat's life-time; and one individual is sufficient for a female flock of one hundred. The males, at all times, but more particularly during the rutting season, emit a powerful smell; they are libidinous, and contend for the possession of the females by butting with their horns, not in the manner of the stag or the bull by running low at each other, but by standing on the hind legs and striking with their whole weight obliquely downward; and during the conflict, they mutter abruptly, lick their lips, and paw the ground."

Yet though these characteristics appear numerous and distinct enough to dissipate all uncertainty and doubt, goats are scarcely distinguishable, by the mere naturalist, from antelopes, and especially from sheep. The main difference relied on by Cuvier is that "the osseous nucleus of the horns is partially porous or cellular, communicating with the sinus of the frontals;" but even this character is regarded by some other naturalists as far from uniform. The domesticated goat and the domesticated sheep, indeed, appear to any ordinary observer to be very different from each other; the former with shaggy hair, and backward or upward bent horns, and the latter with wool instead of hair, and either with no horns whatever, or with horns laterally bent, and for the most part spirally formed. But the wild species—which alone constitute the proper subjects of comparison—are so very closely akin as to have baffled the efforts of many a naturalist to draw a line of demarcation between them; and even the domesticated species, when estimated by their strictly physical characters, differ but a degree or two more than the bull-dog and the greyhound. Cuvier goes so far as to assert—though he becomes extreme and passes into error in so doing—that goats and sheep are more akin to each other than any two races which can produce mere mules, and that, in their wild state, "they produce together a mixed fertile race." The grand distinction between goats and sheep is what some naturalists have expressively though incongruously designated a "moral" one,—a distinction in temper and disposition,—such a distinction as not only associates the idea of the goat with "hircine" smells and propensities, but exhibits that animal in disgusting contrast to the meekness and purity and loveableness of the sheep; and this broad "moral" difference, combined with close similarity or almost identity in physical structure, is possibly the reason why the Divine Reedeemer—He who once came into this world to save men, and will hereafter come again to judge them—compared the two mixed classes of the human race, so like each other in everything physical and so widely different in moral condition, to goats and sheep, and declares that, in the day of judgment, "he shall separate them one from another as a shepherd divideth his sheep from the goats."

Mr. Hodgson, who seems to have been more discriminating on this subject than any other naturalist, selects from the wild races of the goat genus and the sheep genus the fittest type of each, and traces out a surprising number of seemingly differential characters. The whole structure of the goat, according to his estimate, is strong and compact,—that of the sheep less so; the limbs of the goat are thick and rigid,—those of the sheep comparatively feeble and slender; the hoofs of the goat are high and compact,—and those of the sheep are less so; the false hoofs of the goat are well developed,—and those of the sheep are evanescent; the head of the goat is comparatively small and fine,—and that of the sheep is comparatively long and heavy; the facial line of the goat is straight,—and the chaffron of the sheep is arched; the ears of the goat are comparatively short and round,—and those of the sheep are comparatively long and pointed; the tail of the goat is short, flat, and nude below,—and that of the sheep is longer, less depressed, and only half-nude; the withers of the goat are higher than the croup,—and the croup of the sheep is higher than the withers; the fore-legs of the goat are stronger than the hind,—and the hind legs of the sheep are as strong as the fore; the croup of the goat is sloped off,—and that of the sheep is not; the body of the goat is odorous,—and that of the sheep is not; the nostrils of the goat are comparatively moist, short, and wide,—and those of the sheep are comparatively unmoist, long, and narrow; the horns of the goat are of medium size, keeled, and turned upwards,—and those of the sheep are very large, unkeeled, and turned to the sides; the eye of the goat is comparatively dark and keen,—and that of the sheep is comparatively pale and dull; the hair of the goat is long and unequal,—and that of the sheep is short and equal; the back of the goat is arched,—and that of the sheep is straight; the goat bears change of climate well,—and the sheep bears it ill; the goat is eminently curious, capricious, and confident,—and the sheep is incurious, staid, and timid; the goat barks trees with its horns, and feeds on the peel and on aromatic herbs,—and the sheep does not bark trees, and is less addicted to aromatics; the goat, in fighting, rears itself on its hind legs, and lets the weight of its body fall on its antagonist,—and the sheep, in fighting, runs a-tilt, and adds the force of its momentum to that of its weight. Yet, even after such a manifold and perspicacious display of differences between the typal goat and the typal sheep, the very same naturalist, sums up his views of the two genera in the following remarkable terms;—"The goat and sheep have in common hair and wool; no beard; no suborbital sinuses; evanescent muzzle; no inguinal pores; horns in contact at the top of the head; knees and sternum callous; angular and transversely wrinkled horns; striated ears; two teats only in the females; horns in both sexes; and, lastly, incisors of precisely the same form. Of the various diagnostics, then, proposed by Col. Hamilton Smith, it would seem that the following only can be perfectly relied on to separate *Ovis* from *Capra*:—slender limbs; longer pointed ears; chaffron arched; noses long and oblique; very voluminous horns, turned laterally with double flexures. I should add myself the strong and invariable distinction —males not odorous, as opposed to the males odorous of the genus *Capra*. But, after all, there are no physcial distinctions at all equivalent to the moral ones so finely and truly delineated by Buffon, and which, notwithstanding what Col. H. Smith urges in favour of the courage and activity of sheep, will for ever continue to be recognised as the only essential diagnostics of the two genera."

The wild species of goat inhabit alpine mountains, near the limits of perpetual snow; and even such of the domesticated varieties as live in mountainous districts, continue to climb while grazing, till thirst or the love of home recalls them to the valley. All goats leap with precision on very difficult ground, and love to look over precipices, and to climb to the summits of beetling crags and lofty pinnacles; and when two meet on such a narrow ledge of rock as will not admit of their passing each other, the one lies down, and the other walks over its back. They are always in motion, ever in search of new objects, constantly fermenting with insatiable curiosity; and though not disinclined to associate with the animals of a farm or with man himself, they are unsteady in their feelings, and continually prone to break bounds and wander. They are acute in sensation, far-sighted in vision, keen and delicate in the sense of smell, and wayward, audacious, and fearless in disposition; and when grazing or passing from place to place in company with sheep, they always take the lead, and allow the sheep to follow. "None of the species are large in stature; but their structure is robust, and their habits vigilant. The chase of them is, therefore, both laborious and dangerous; for every strange object is seen at a great distance, and, if suspicious, avoided by a retreat, which defies the skill and industry even of the most intrepid hunter, and often causes his life to be sacrificed, by the dangers of the precipices, the ice, or the animal, driven to despair, bolting down upon him, and plunging both headlong into the abyss. The wild species can mount a perpendicular surface, 15 feet high, at three leaps, or rather three successive bounds of 5 feet each, if the slightest rugosity will suffer the renewals of ascending force, while the original impulse is still sufficient to retain the given direction. Between two perpendicular rocks, close together, they mount by alternate bounds from one to the other. In cases of fear, their voice is a short sharp whistle, stronger than the chamois; at other times, it is a snort; when threatening, it is a broken spluttering sound; and when young, they bleat. The females are attentive and affectionate to their young, and will defend them against wolves and eagles." Goats readily find sustenance in situations where bovine animals or even sheep would starve; and are so extremely coarse in their tastes and indiscriminate in their digestion, that they will feed on plants, such as the cowbanes and the spurges, which are noxious to other animals, on the buds and bark of shrubs and trees, and even on such nauseous and narcotic stuff as manufactured tobacco.

Goats and sheep seem to have been among the last of the geological series of animals which appeared upon earth, so as to have preceded by but a link or two the creation of man. Any remains of them which have been found, like the remains of man himself, occur in such perfectly recent deposits, or in such strictly superficial situations, as to prevent them from being regarded, in any ordinary sense of the word, as fossils. The remains of sheep found in Goat's Hole at Paviland in Glamorganshire, for example, seem very clearly to have belonged to animals which were taken into the place for food, and occurred in connexion with a human skeleton which Dean Buckland dates no higher than the period of the military occupation of the adjacent summits about the time of the Roman invasion. Yet though no fossil goats or sheep have anywhere been found, living goats occur, in a wild state, in three or perhaps in four of the great divisions of the globe, and living sheep occur, in a wild state, in almost every great portion of the world, with the exception perhaps of New Holland. "It would almost seem," to quote Cuvier again, "as if this class of animals were added, by the all-bountiful hand of Providence, to the stock of other creatures, for the express purpose of being the instruments which should lead man to industry and peace. * * The wandering shepherd guided his nightly course by the stars; he observed the connexion of the seasons by the passage of the sun through certain portions of the heavens; he named the stars within this range after the objects most familiar to his mind; and his zodiac was formed with Capricorn and Aries among its members or houses. These names, at first applied for the purpose of divisional designation, as they stood connected with real or supposed duties or events relating to pastoral life, gradually acquired the character of sacred; and the same minds which had selected them from common objects, by no uncommon transition, typified them with characteristic attributes, and then regarded their representatives as objects of veneration, of hope, or of fear. In the early mythologies, Pan, the supreme power over nature, is portrayed with the insignia of the goat, and the Libyan Jupiter with the horns of the ram; Osiris or the Sun, during the vernal period of the year, assumes the same characters; and the Grecian Jupiter and Minerva claim alike the ægis or goat-skin for a breastplate. Both the goat and sheep were held sacred to one or more divinities, and sacrificed at their altars. In the Jewish law, they were likewise sacrificed, but not with the same intention; for here the goat 'and the sheep also' were expressly marked as emblematical of atonement; and in the Christian dispensation, the beautiful image of exalted innocence bearing the sins of mankind, is still retained in the figurative designation of the Lamb."

The different kinds of domesticated goats, though exceedingly numerous, and diffused over the greater part of the world, and diversified by the influence of different climates and the pastoral usages of different countries, are easily reducible to a single species. But the different kinds of wild goats, though far fewer in number, and not at all affected by artificial circumstances, exhibit very wide diversities, and require to be distributed into several species. Linnæus regards the domestic goat as an original or underived species: but the vast majority of naturalists, though widely disagreeing among themselves in some important particulars, regard it as a modification of some one or other of the existing species of wild goats. The older naturalists, with the exception of the immediate followers of Linnæus, generally derive it from the ibex; the majority of modern naturalists derive it from the paseng or ægagrus; and a few, including Pallas and Pennant, derive it conjointly from these two species, or regard it as a hybrid. We shall first give a brief notice of the several wild goats, and then consider the varieties, habits, and uses of the domestic goat.

The ibex or European ibex, *Capra ibex*, inhabits the upper regions of the loftiest mountains of Europe; and, though probably at one time abundant, is now comparatively rare. It possibly exists in some of the most alpine heights of Greece; it has become nearly extinct in the Pyrenees; it is somewhat scarce on the alps of Savoy and Switzerland; and it occurs in greatest number, but still very sparingly, in the alps of the Tyrol. It frequents the highest verge of vegetation, near the limits of perpetual snow, and, in some places, ascends higher than the chamois; it is hunted partly for its flesh, but chiefly for its skin, and is one of the most difficult and dangerous beasts of chase in Europe; it exercises keen vigilance, has great delicacy of hearing and smell, bounds like the chamois among alpine precipices, crags, and pinnacles, and, when driven to extremity, turns on its pursuers, and either holds them at bay or perilously assails them with its powerful horns. Its length is nearly 5 feet; its height is from 2½ feet to 2 feet 10 inches; and its horns are flat, and have two lateral ridges, and numerous cross ridges or transverse knots, and uniformly diverge and falcate backward, and are dark coloured, very strong, and sometimes 2½ feet in length. The hair of its belly and the inner part of its thighs is always whitish; and the hair of most of the other parts of the body is a light ashy grey in youth, deepens into brown at maturity, and changes from a red-brown in summer to a grey-brown in winter; but the face and the dorsal line are black, the inside of the ears and the lower part of the tail are white, and the head under the chin is dark-brown. The great body of the hair is always comparatively short and compact.

The Caucasian ibex, *Capra Caucasica*, inhabits the Caucasian mountains, and probably exists also among the lofty mountains of Eastern Persia. It equals or even excels the European ibex in agility and strength, makes prodigious leaps with apparent ease, and bounds from lofty precipices to the depths below without sustaining injury. It resembles the European ibex in size and form, but is shorter and broader in the body, and possesses other distinctive characters. Its horns are triangular, and have projecting knots, with uniform transverse wrinkles; its body is dark brown above and white below; its head is black round the mouth, and grey in other parts; its breast and its dorsal line are black; and its hair has much greyish under-wool, and is somewhat hard in texture.

The Jaela or Abyssinian ibex, *Capra Jaela*, abounds in the mountains of Abyssinia and Upper Egypt, inhabits the borders of the Red Sea, and probably occurs in the mountains of Atlas. It is supposed to be the akko or wild goat mentioned in the book of Deuteronomy, and the jaal or wild goat mentioned in the book of Job. It stands higher than either the European ibex or the Caucasian ibex; and is "of a dirty brownish fawn colour, with a short beard, and lengthened hair under the throat down to the breast, and a darkish line on the anterior part of the legs and along the back; the ears appear shorter, but the horns, of a dirty colour, are superior in length to those of the European ibex, forming a half-circle, closer on the forehead, less diverging backwards."

The paseng or ægagrus, *Capra ægagrus*, occurs on the mountains of Taurus, the mountains of Caucasus, and the mountains which extend from the north of Persia, along the north of India, all the way to China: and it is particularly known to the Turkomans, the Kirghiz, and the nomadic tribes of Northern Persia. It was first made known in Europe, and at the same time surmised to be the probable origin of the domestic goat, by Pallas and Gmelin. It stands higher, and has a more slender body, than the largest varieties of the domestic goat; its tail is very short; its limbs are strong and thick, and have not the agile appearance of those of antelopes and stags; its neck is short and thick; its head is but little lengthened, and is usually carried high; its face is covered with long, silky, loose, and very soft hair; its horns are triangular, covered with transverse ridges, and about 3 feet long, and form an acute angle to the front, and are always bent backward; its look is fixed; and its movements are rapid, bold, and easy. "The fur is greyish-brown above, with a dark line on the back, and a black tail; the head black about the nose, rufous at the sides; the beard and throat brown." This species is supposed to have yielded the oriental bezoars which, in ancient times, possessed so great an artificial value. See the article BEZOAR.

The Jemlah goat, *Capra Jemlanica*, is an interesting and peculiar species. It is said to inhabit a district called Jemlah, among the culminating heights of central Asia, at the watershed between the western and the south-eastern branches of the Himmalayan mountains; and it may possibly represent the ægagrus, or be the animal to which the name of that species has been given, throughout the portions of the northern Indian alps which extend from the basin of the Bramhapootra to the borders of China. But it is known to us only from a single skull and skin formerly in the British Museum; and is described as follows, by Major Smith, in Griffith's Cuvier: "The size of the animal appears nearly equal to the ibex; the facial line is straight, though the prominences of the horns give the forehead a concave appearance; the eyes are rather small; the ears short, narrow and rounded at the tips; the horns stand obliquely on the frontals, rather high above the orbits, nearly in contact at base, extremely depressed, almost flat, four inches and a quarter in breadth at the root, nine inches long, inclining outwards, then suddenly tapering into a point which turns inwards, so as to nearly meet over the neck; their colour is pale-ashy buff, the anterior edge marked with seven small protuberances, round, distinct, almost detached, shaped like drops, being gradually obliterated as they ascend, and each marking the commencement of a wrinkle, which passes round the external flattened surfaces, in the form of grooves, resembling the joints of a lobster, and leaving about four inches smooth, where they contract into a point; the bones of the head are exceedingly solid and ponderous, without a void space on each side of the nasal bones, as is the case in the Caucasian and ægagrus species. The hair of the face and legs is short, marked with a dark earthy coloured streak down the chaffron; that of the neck and back is very abundant, long and loose, with a streak of the same dark sepia colour down the ridge of the spine; the tail is very short; on the sides of the cheeks, the hair is exceedingly long and coarse, hanging like a lion's mane on each side of the head, and feathering vertically also upon the shoulders; excepting the dark streaks before mentioned, and a darkish line on the anterior part of the legs, the whole animal is of a dirty-whitish fawn, with a few locks of brown interspersed. It has no true beard, and the limbs are remarkably robust."

The Jahral goat, *Capra Jahral*, occurs solitary or in small flocks in the Kachan region of Nepaul. It shares largely the strong and peculiar interest of the Jemlah goat, and is scarcely better known, yet has been described by Mr. Hodgson from specimens in his own possession. Its length is a little upwards of 4 feet, and its height 2¾ feet; its head has a fine form, a full expression, and a coat of close short hair, but is perfectly free from any beard; its horns are compressed, subtriangular, uniformly marked with transverse wrinkles, and about 9 inches long, and they have thin, smooth, anterior edges, and are inserted obliquely in the crest of the frontals; its whole form is strong and compact; and its disposition is eminently wanton and capricious, and remarkably bold and pugnacious, yet easily subdued and singularly capable of domestication and change. Its prevailing superficial colour is a saturate brown; its prevailing under-colour, and also the surface-colour of most of the mane, are a heavy blue; its face and cheeks, and the fronts of its limbs are blackish-brown; its lip and chin are hairy, and have on each side a blackish patch; its tongue and palate are black; and its fore-arms, the lower part of its horns, and the back parts of its legs have a rusty colour.

The Cossus goat, *Capra Cossus*, occurs in India, and is supposed to be, neither a distinct species nor a variety of the common domestic goat, but a variety of the Jemlah goat. All its hair is long, white, and uncurled; its horns incline backward throughout their length, and outward at the points; its ears are horizontal; its forehead is prominent; its chin is beardless; its face is clothed with very long hair, so turned to the sides as to divide the middle line of the chaffron; and its tail is short and curled.—The recumbent horned goat, *Capra depressa*, is a small, domesticated animal, and was introduced to South America from either Manilla or Western Africa, and is supposed to be also a variety of the Jemlah goat. Its hair is long; and its horns are much depressed, and lie recumbently on the back of the head.—The aoudad, *Capra tragelaphus* or *Ovis tragelaphus*, holds a very doubtful place between the caprine and the ovine groups, and is regarded by some naturalists as a goat, and by others as a sheep. It resembles goats in being hairy, in having a concave chaffron, and in wanting suborbital sinuses; but it resembles sheep in the structure of its horns, and in other characters. It occurs throughout the north of Africa from Barbary to Upper Egypt, and is particularly abundant among the wildest and loftiest heights of the Atlas mountains.

The domestic goat, *Capra Hircus*, comprises a greater range of varieties than any other animal except the dog, and is as much at home amid the arctic cold of the Norway mountains as beneath a vertical sun in the equatorial regions of Asia or Africa. Some varieties approach so near in character to the ægagrus or the ibex as to be almost undistinguishable by the unpractised eye; and other varieties are so exceedingly dissimilar from these as to seem to almost all persons except naturalists to belong to a totally different section of the animal kingdom. Yet multitudinous and surprisingly diverse as the several kinds are, they fuse their characters into one another by such insensible gradations, and at the same time possess some grand specific peculiarities so decidedly in common, that they as truly resolve themselves into one species as the numerous and vastly diversified group of dogs. The varieties which differ least from the ægagrus, are smaller in body, more coarsely clad, and less recumbently horned than that species, and have small upright ears, and have a general colour of body passing from blackish-brown to sandy, black and white; and most of the varieties farthest removed from the ægagrus have a smooth coat, white, brown, and reddish colours, diversified horns, pendulous ears, and small glands pendent beneath the throat, while a few are policerate, or four-horned, or otherwise so startlingly dissimilar from their type as almost to appear monster-goats.

"The common goat, which is well known in the north of Scotland and the most alpine counties of England and Wales," says Sir William Jardine, "closely resembles the wild ægagrus, and in some parts of the Highlands has become nearly naturalized, and scarcely to be approached except by stealth, or procured except by the assistance of the gun. We recollect once having a flock of this description pointed out to us on the precipitous side of Ben Nevis, and of endeavouring to get a shot in vain; their activity among the rocks surpassed any thing we could have imagined from description, and they had passed the rocky valley long before we had reached the station pointed out for an ambuscade. A Welsh breed, generally of a white colour, is remarkable for its long hair and very large horns, which are sometimes three feet in length. In Holland, they are used in very pretty equipages for children, and we have seen two and sometimes four, harnessed to a child's car, obeying the rein, and apparently in complete subjection. As among the sheep, we have also a breed, white, and without horns; and here the distinction of the two forms is very close indeed, and scarcely to be distinguished, except by the hairy fleece and indication of a beard."

The Jueda long-haired goat is smaller in size and stands considerably lower than the Welsh goat; its hair is long and fine, and, in many cases, white; and its horns are depressed, and have both an outward and an upward bend.—The short-horned goat is nearly allied to both the Welsh goat and the Jueda goat, but has variously coloured smooth hair.—Some of the goats of Sweden, and also some of those of Spain, are hornless, and have long and, in many cases, white hair.—The Persian goat is probably less removed from the wild type than either the Scottish or the Welsh goat; its horns have the same form as those of the ægagrus, but are smaller; its hair is long, coarse, and ashy-brown; and a large tuft of it grows between the horns, and has the same kind of appearance as the fetlock of a horse.—The dwarf goat of South America and the West Indies, seems to have been originally derived from the *Capra depressa*, but has become abundantly intermixed with other breeds. It dreads thunder, and is peculiarly sensitive to rain. Its hair is close and short, and usually has a whitish colour inclined to fawn colour; but its beard, its neck, its legs, and its tail are commonly black. Most of the goats of this breed are hornless; and a few of the females have each four mammæ.

The Cashmere goat, whose wool or fine hair forms the material of the celebrated Cashmere shawls, inhabits the lofty country round the sources of the river Indus, in the extreme north-west of India, and on the borders of Thibet. Its horns are pale brown, but slightly spiral, and considerably upright; its ears are large and brown or blackish, and are turned downward; its limbs are slender and cleanly formed; and its fleece is long, straight, white, and silky. "Sixteen thousand looms," we are told, "are supposed to be in constant motion at Cashmere, each giving employment to three men. The wool of Thibet is thought to be the best. Twenty-four pounds weight of it sells at Cashmere, if of the best sort, for twenty rupees; but an inferior and harsher kind may be procured for half the money. The wool is spun by women, and afterwards coloured." Some Cashmere goats were brought to Britain, a number of years ago, and attempted to be naturalized; and after a fair trial, they continued to be healthy and to possess all the original fineness and silkiness of their fleece; and some shawls which were manufactured from their wool were pronounced by competent judges to be exceedingly good. But whether the goats would thrive on ordinary pastures, away from the niceties of special care and shelter, and whether especially they would transmit their fineness of fleece to their offspring through successive generations, are points which admit of very serious doubt.

Another Indian goat besides the Cashmere one, and very closely akin to it, yields wool of the soft and silky kind used for the shawls. "We possess a drawing of an Indian variety," says Cuvier, "with long curling hair, of a white colour, nearly allied to the Cashmere breed, but retaining small upright ears. The horns are yellowish and angular, with a triple spiral turn, directed outwards; the female with short curved horns turning downwards, and the face and legs fawn-colour. —The Thibet or Tartar goat is also allied to the Cashmere goat. Its horns are but very slightly spiral, and of an ash-colour; its ears are smaller than those of the Cashmere goat, and pendent; its limbs are strong; and its fleece is white and very fine, but is occasionally blotched with black. This breed has been introduced to France. —The Angora goat inhabits a district around Angora and Beibazar in the part of Asia Minor which constituted the ancient Cappadocia. The horns of the males are yellowish, and nearly upright, making about only one turn in their ascent; and those of the females are short and have a downward inclination. The ears are long and buff-coloured; the face has a form and expression very similar to those of domestic sheep; and the hair or wool is long, soft, and generally white. The goatherds who tend the native flocks of this breed, bestow great care on them, with reference to their fleece, and often wash and comb them. An attempt was made by Baron Alstrœmer to naturalize the Angora goat in Sweden; but it seems to have completely failed.

The Nepaul goat has a widely different appearance from any of the varieties of domestic goat already mentioned,—so much so as almost to seem a perfectly distinct and broadly marked species. Its horns are very short, and almost as spiral as a screw; its nasal bones are convex or raised, so as to give the nose an arched form; its ears are pendulous, longer than the head, and of a white colour, speckled with black; its lips, its chin, a spot on the forehead, and a spot on the breast are white; its hind legs are comparatively long and high; and its hair is loose, longish, and either black or slaty-grey.—The Egyptian goats also have a very singular appearance. The horns of one of the breeds are depressed and half-spiral; its ears are pendent and small; and its hair is very generally brown. The horns of another are very spiral; its ears are longer than its head; and its hair is close, smooth, and generally brown. The horns of a third are either small or a-wanting; its ears are very long and broad; and its hair is longish and rufous-brown. The horns of a fourth are always a-wanting; its nose is very much raised; its chin and teeth are bare, and remind one of the pugs among dogs; its ears are large and pendent; its hind legs, like those of the Nepaul goat, are comparatively high; its hair is coarse and of a rufous-brown colour; and the udder of the female is always very pendent, and sometimes almost touches the ground.—The Syrian goat abounds in various parts of the East, and is said by Pennant to supply Aleppo with milk. Its horns bend outward and are somewhat erect and slightly spiral; its ears are pendent and longer than its head; and its hair is long, and frequently black, but with the head and legs white, and only mottled with black.

The domestic goat, in almost any of its varieties, but especially in the best and most common of them, is an animal of great utility to man, and, if properly treated, would, in bleak, bare, and mountainous districts, be more valuable than even the sheep. Its skin, with the hair on, was probably an extensive and long-continued article of clothing among the ancients; and is still so used by some of the peasantry of the Scottish Highlands, and by many of the inhabitants of Brittany and Normandy. Its skin, in a dressed state, particularly the skin of the kid or young goat, is of great importance in the present day to glove-makers, and is said to be more susceptible of dyes than any other kind of skin.—The horns are good materials for knife handles.—The hair of the woolly and silky fleeced varieties is a material of great mercantile value for the manufacture of shawls and similar fabrics. But even goat-hair, in general, is of much worth. It was anciently combined with the short fur of other animals, and with vegetable gum or animal glue, for the manufacture of a solid kind of felt which was very long and extensively used in Northern Asia; and it formed a chief material of several sorts of fabrics for wearing apparel, in some of the Roman provinces before the time of Constantine, and among the Scandinavian tribes of the middle ages. "That goats' hair was the chief ingredient among the Scandinavians," says Cuvier, "is proved by their divinities being dressed in *Geita Kurtlu*. The domestic goat in the north and west of the old world, preceded sheep for many ages, and predominated while the country was chiefly covered with forests; nor is there evidence of wool-bearing animals crossing the Rhine or the Upper Danube till towards the subversion of the Roman Empire." The hair of the haunches, where it is usually thicker and longer than elsewhere, brought a high price from peruquiers in the days of general wig-wearing, and is still used for making the wigs of barristers, judges, and other wigged dignitaries.

The flesh of the goat, and particularly that of the kid, was formerly in great and general request as an article of food, but is at present very generally disliked. The flesh of the adult goat, especially of one somewhat advanced in age, is tough and strong-tasted, yet does very well to be salted and made into bacon, and is so treated in Wales. "The haunches of the goat," says Pennant, "are frequently salted and dried, and supply all the uses of bacon; this by the natives is called *Coch yr wden* or hung venison. The meat of a castrated goat of six or seven years old, which is called *hyfr*, is reckoned the best, being generally very sweet and fat. This makes an excellent pasty, goes under the name of rock-venison, and is little inferior to that of the deer." The flesh of the kid is so tender and well-flavoured as not to be surpassed by that of the best lamb; and is as nourishing as it is delicate. Nothing, therefore, but culpable ignorance or absurd prejudice prevents as brisk a demand for goat's flesh in the shambles of mountainous districts as for the flesh of sheep and lambs in the shambles of low and extensive plains.—The suet of the goat is said to make whiter and in all respects better candles than that of the sheep or the ox.—The milk of the she-goat is light, rich, and nourishing; it possesses qualities intermediate between that of the cow and that of the ass, being more serous than the former and less so than the latter; it curdles easily, and makes a very palatable cheese; it has been long extolled, as has also been its whey, for medicinal virtues; and it is yielded freely to the hand, in comparatively large quantities, and during a comparatively long time. "To those who are unable to keep a cow," remarks Martin Doyle, with special reference to the cottiers and small farmers of Ireland, "the goat is a treasure when giving milk, which she will yield for several months, if well fed, at the rate of two quarts a-day."

Goats do well to be confined in yards as pets for children; and form fine subjects for the exercise of the care and the gentleness which all young persons, especially in country situations, ought early to acquire for every kind of domestic animal. Goats do well, also, to be tethered to limited spots, by the wayside, on patches of waste ground, or in the corners of fields or paddocks to feed upon coarse herbage or redundant grasses, for the sake of yielding milk to invalids or cottiers. But, in almost any other circumstances, they are ill-adapted or not adapted at all to low, enclosed, and well-cultivated districts; for, besides being far less profitable in such situations than sheep, they overleap fences, browse upon the twigs of hedges, and constantly do considerable damage by their peculiar tastes and habits. In mountainous districts, however, they are of great value, and ought to be in very extensive request. Goats can feed well where sheep would almost or altogether starve; and, in many a bare, bleak, rocky region, like a large portion of Wales, of the Scottish Highlands, and of the counties of Kerry, Galway, Mayo, and Donegal, they could find sufficient sustenance where not another British domesticated animal could live, and would at the same time occasion exceedingly little cost or trouble to their owners. The domestic goat, like the wild one, thrives on many a plant which would disgust or perhaps kill other domestic animals; and like the wild one, too, it easily climbs to the least accessible and the most unpromising acclivities of rocky mountains, in search of food. Goats, in most situations, might add materially to the comforts of the poor; and goats among the mountains might remove multitudes of families from a state of indigence to a condition of pastoral ease and comparative competence. "It is surprising," remarks Martin Doyle, "that goats are not much more numerous than they are in our Irish mountains, where they might be maintained almost literally without expense. To see a female kid so often sold by the necessitous poor for a shilling, though its life if spared would be so great a source of comfort to them, is a melancholy manifestation of extreme distress."—*Cuvier's Animal Kingdom.—Bell's History of British Quadrupeds.—Jardine's Naturalist's Library.—Pennant's British Zoology.—Buffon's Natural History.—Transactions of the Zoological Society.—Doyle's Works.—Low's Works.—Quarterly Journal of Agriculture.—Mortimer's Husbandry.—Culley on Live Stock.—Treatise on Pasturage.*

GOATFOOT, or GOATWEED,—botanically *Ægopodium.* An indigenous, perennial-rooted, herbaceous plant, of the umbelliferous order. It constitutes a genus of itself, and takes for its specific name podagria or podagraria. It occurs in shady situations in both England and Scotland, has usually a height of about two feet, and carries white-coloured flowers from May till July. The form of its leaves is fancied to resemble that of a goat's foot, and gives occasion to both the popular and the botanical name. The peasantry regard the plant as medicinal. A variegated variety of it sometimes occurs.—See the articles GOATWEED and GOAT'S-FOOT.

GOAT-MOTH,—scientifically *Cossus Ligniperda.* A British lepidopterous insect, of the moth tribe. The male of the imago sometimes measures upwards of 3 inches in expanse of wing, and the female upwards of 3½ inches; and both are beautiful objects, and of somewhat common occurrence. The front wings have cloudings of grey and brown, and many transverse irregular streakings and markings; and the hind wings have a dusky colour, with faint irregular streaks and markings toward their posterior margin. The imago is sluggish during the day, and almost constantly reposes among the foliage of trees. The caterpillar spends the enormous period of three years before passing by transformation into a chrysalis, and eventually attains a comparatively gigantic size. Its head is black; its body is of a dull rufescent colour, with large shining red blotches on the back; and its place of retreat is a shroud of ligneous matter, strongly agglutinated with a sticky secretion and lined with a silky substance. It emits a most abominable odour, ensconces itself in oaks, poplars, willows, and other trees, and eats progressively inward to their duramen so as to inflict extreme injury upon their timber; and it thus makes the interior of trees at once its summer home, its daily food, and its place of hybernation.

GOATROOT,—botanically *Ononis Natrix.* An evergreen undershrub, of the restharrow genus, and broom division of leguminous plants. It grows about 20 inches high, and carries yellow flowers from May till September. It was brought to Britain from the south of Europe upwards of 160 years ago; but is of small value.

GOAT'S-BANE,—botanically *Aconitum Tragoctonum.* An ornamental, poisonous, hardy, perennial-rooted, herbaceous, aconite, introduced to Britain about 25 years ago from Switzerland, and usually attaining a height of about 30 inches, and carrying pale yellow flowers from June till August. See the article Aconite.

GOAT'S-BEARD,—botanically *Tragopogon.* A genus of hardy, biennial, herbaceous plants, of the succory division of the composite order. The leek-leaved species, *T. porrifolius*, grows wild in some moist meadows of England, and is the well-known salsify of our kitchen gardens. See the article Salsify.—The meadow species, *T. pratensis*, grows wild in rich pastures, with a somewhat moist soil of clay or loam, in various parts of England and Scotland. Its root is tapering; its stems are cylindrical, leafy, frequently purplish, and usually about two feet high; its leaves are long and taper-pointed, and have a deep green colour, and often curl at the end; and its flowers are bright yellow and about two inches broad, and bloom in May and June, and usually open very early in the morning, and close before noon. The peasantry gather this plant when it is about 4 inches high, and boil and use it in the same way as asparagus; and, on account of its peculiar habit when in bloom, they often call it Sleep-at-noon or Go-to-bed-at-noon.—The greater species, *T. major*, a native of Austria, but long known in Britain, has sometimes been confounded with the meadow species, yet is very different from it, and a far larger plant, with stems from 3 to 6 feet high, and lower leaves three-fourths of an inch broad at the base, and upwards of a foot long.—Upwards of a dozen exotic species, mostly with yellow or purple flowers, have been introduced to Britain; and several more are known.—Goat's-Beard is also the popular name of *Spiræa aruncus*, a handsome, pleasant, hardy, perennial-rooted, herbaceous, white-flowered species, of about 4 feet in height, introduced upwards of two centuries ago from Siberia, and comprising a North-American variety.

GOAT'S-FOOT,—botanically *Oxalis Caprina.* A pretty, little, bulbous-rooted, Cape-of-Good-Hope plant, of the wood-sorrel tribe, introduced to Britain about 90 years ago. It has a height of only two or three inches, and bears a flesh-coloured flower from March till June.

GOAT'S-ORIGANUM,—botanically *Thymus Tragoriganum.* A beautiful, little, undershrubby thyme, of about a foot in height, introduced upwards of two centuries ago from Crete.

GOAT'S-RUE,—botanically *Galega.* A genus of hardy, ornamental, perennial-rooted, herbaceous plants, of the lotus division of the composite order. The officinal species, *G. officinalis*, is a native of Spain, and was introduced to Britain in the latter part of the 16th century. Its root consists of many strong fibres, which are frequently jointed; its stems are numerous, hollow, channelled, erect, and about 3 feet high; its leaves are pinnate, each comprising 6 or 7 pairs of leaflets and a terminating odd one; its leaflets are long, pointed, entire, and smooth; its stipules or bracts at the base of the leaves are small and sagittate; its flowers are produced in racemes or loose spikes from the top of the stem, and have a light blue or light purple colour, and bloom from June till September; and its pods are erect, nearly cylindrical, from five to eight seeded, and swollen out with air. One variety occurs with white flowers, and another with variegated flowers. This plant was long ago cultivated in gardens for medicinal purposes; and it has, of late years, been recommended as a forage plant for cattle. But though it yields a large bulk of produce, and is perhaps equal to some cultivated field green crops in nutritiveness, it is refused by cattle except in small quantities and when nothing better can be had; yet it might possibly come to be relished after a number of trials, or it might, at all events, be combined in small proportions with more agreeable fodder. It is reputed to possess the property of increasing the secretion of milk in animals who eat it; and it hence gave to the genus the name of galega, which is formed from the Greek word for milk. Three other blue-flowered species, and a white-flowered one, were introduced to Britain between the years 1800 and 1830.

GOAT'S-THORN. See Astragalus.

GOAT'S-WHEAT,—botanically *Tragopyrum.* A small genus of ornamental plants, of the polygonum tribe. Three species, the box-leaved, the lanceolate, and the polygomous, all deciduous undershrubs about two feet high, and bearing pink-coloured flowers in July and August, and formerly included in the polygonum genus, have been introduced to Britain; and three or four other species are known.

GOATWEED,—botanically *Capraria.* A diversified genus of tender white-flowered plants, of the figwort family. Two annuals have been introduced from India and tropical America, and three evergreen undershrubs from America and the Cape of Good Hope; but they do not possess much interest. Several other species are known.

GODETIA. A genus of beautiful, hardy, annual plants of the clarkia and fuchsia tribe. The ruddy species, *G. rubicunda*, now a widely diffused and very favourite annual, with stems about two feet high, and a great profusion of large, handsome, pale flame-coloured flowers, was introduced to Britain from California in 1834; and at least ten or eleven other very handsome species were introduced from California, Chili, and other countries, before the close of 1842. The principal good ones, up to that date, were *G. lepida, vinosa, grandiflora, Lindleyana, viminea, decumbens, Romangovii, amæna, bifrons, tenella,* and *tenuifolia;* and all these, except the two last, may be sown in the open border in autumn, and will stand over any ordinary winter, while the whole may be sown in the open ground in spring or summer. All the best known species have some shade of blush, pink, or pale flame-colour, make a very showy appearance, are extremely easy of cultivation, and have deservedly become great favourites with the cultivators of hardy annuals.

GO-DOWN. A single gulp of water, allowed to a heated or fatigued horse while journeying or working.

GODWIT,—scientifically *Limosa*. A genus of birds, of the snipe and curlew family. The bill of each species is soft, flexible, curved upwards, and very long; the apex of the bill is obtuse, dilated, and depressed; the upper mandible is furrowed; the legs are slender and long; the hind toe is small; and the outer and inner toes are connected by means of a basal web. The godwits are larger than some other esteemed aquatic birds, but are in less request for the table. The black-tailed species, *Limosa melanura*, breeds sparingly in some of the English fens, and abundantly throughout the northern countries of Continental Europe; it is oftenest seen in England in spring and autumn, and begins to lay its eggs in the early part of May; and it frequents oozy shores and the silty mouths of rivers, during the winter months, plunging its bill into the soft alluvial deposits in search of larvæ, worms, and marine insects. The male is about 16 inches, and the female about 17 inches, in total length; and the bill of the male constitutes 3¼ inches of this total. The colours of the male are brighter than those of the female; but in consequence of a double moult, the colours of both are different at different seasons, and the young birds have been mistaken by some naturalists for members, not only of other species, but of quite different genera. The winter plumage exhibits the claws black, the chin, breast, and belly light ashy grey, and the head, neck, and back ashy brown.—The common, red, or bar-tailed godwit, *Limosa rufa*, is not known to breed in Britain, yet is much more abundant than the black-tailed species in winter. It frequents the coldest or most northerly parts of Europe during summer. It closely resembles the other species both in appearance and in habit, but may be readily distinguished by the deeper shade of its brown, by the whiteness of its breast and belly, and by the barred markings of its tail-feathers with greyish white and dark brown.

GOGGLES. See HYDATID.

GOLD. A well known precious metal, one of the simple or elementary substances of chemistry. It exists naturally as a metal, either by itself or in combination with other metals; it occurs in pubes, in grains, and in masses; and it is found sometimes on mountains of primitive rocks, but more frequently in the recent alluvium or surface sands of streams: "Africa and America," says Brande, "are the richest countries in gold. In Africa it always occurs in the beds of rivers and in the alluvial soils of the plains, either in small grains, or in masses of different sizes. The principal tracts, rich in this precious metal, are in the western parts of Africa, to the south of the great desert of Zara, and between Darfur and Abyssinia; and the sands of the Gambia, Niger, and Senegal, are all auriferous. It is supposed that Ophir, whence Solomon obtained gold, was a country on the south-east coast; and Herodotus relates, that when the messengers of Cambyses waited upon the king of Æthiopia, they were shown the prisoners bound in chains of gold. As this metal is found in a ductile, tenacious, and workable state, it is almost the only one employed by savage nations, and various ornaments and utensils are frequently made of it. These untutored tribes have always regarded the eagerness of their European invaders to obtain it with the utmost astonishment; of this the history of America furnishes us with many curious instances. In one of the early incursions into the interior of that continent, the Spaniards contested with such eagerness about the division of some gold, that they were on the point of proceeding to acts of mutual violence, when a young casique, who was present, tumbled it out of the balance with indignation, and turning to the invaders, 'Why,' said he, 'do you quarrel about such a trifle—if it be for gold that you abandon the regions of your fathers, and disturb the peaceful tranquillity of these distant nations, I will conduct you to a region abundant in this mean object of your admiration and desire.' The thirst for gold was the principal incentive to the almost more than human enterprises performed by the followers of Columbus. Animated by the certain prospect of gain, they pursued discovery with greater eagerness than when excited only by curiosity and hope. The riches of Peru, Mexico, and Brazil, are well known, and the gold is there principally found in the beds of rivers, although *veins* have been successfully worked. Asia cannot at present be deemed rich in gold, although it has been found in Ceylon, Borneo, Sumatra, and some of the Archipelago islands. Of the abundance of gold which once enriched the Pactolus we now know nothing. Nor can Europe boast of golden treasures. According to Diodorus Siculus, and Pliny, the Phœnicians and Romans procured considerable quantities of gold from Spain. The poets too found it in the sands of the Tagus. In France it has been found in the department of the Isere; in the Rhone at its junction with the Araw; in the Rhine near Strasbourg and Germersheim, but neither above nor below it; and in the Garonne near Toulouse. In Piedmont, in the valleys at the foot of Mount Rosa, and of the Simplon; and also in the small streams that intersect the red alluvion, about Chivasso. The only important gold-mines of Europe are those of Hungary." Gold occurs in many a district of Great Britain and Ireland, but scarcely anywhere in sufficient quantity to repay the cost of search and gathering; and, though in some places, as at Leadhills in Scotland and the vicinity of Arklow in Ireland, it was formerly obtained in considerable amount, it eventually occasioned, even in these places, very wasteful or wild expenditure of the time and labours of adventurers. A search for gold in Britain seems at present to be only a degree less absurd than the attempts of the old alchemists to form it out of the baser metals.

Gold is distinguished from all other metals by its yellowness and its extraordinary malleability and ductility. It is less brilliant than silver, mercury, or steel; but may be exposed for ages to the atmosphere without undergoing oxidation or other chemical change. It is as soft as lead, and has a specific gravity of 19.3; it does not melt at a less heat than about 2016° of Fahrenheit; and a single grain weight of it may be beaten out to a surface of 56 square inches, or wire-drawn to a length of 500 feet. If intensely acted on by electricity or the oxyhydrogen blowpipe, so as to be raised to a surpassingly high temperature, it burns with a greenish-blue flame, and passes into a purple powder, which chemists suppose to be a combination of it with oxygen. The only known substances which have the power of dissolving it are chlorine and nitro-muriatic acid. Gold being a simple substance, is of course unsusceptible of decomposition; but, like most other simple bodies, it is never found in the earth in a state of purity, being always more or less combined with silver. Although the mines of Colombia have long been celebrated for the quantity of gold found in them, yet it has recently been ascertained that the native ore of that country contains a smaller proportion of gold than that of most others. According to the experiments of Boussingault, who analyzed gold ore from different places in Colombia, he found it combined with silver in variable quantities, but invariably in definite proportions, namely, one atom of silver with 2, 3, 4, 5, 6, 8, and 12 atoms of gold. We are informed by Fordyce, that he examined gold ore from Konsberg in Norway, and found it to consist of 28 parts gold, and 72 of silver, in the 100 parts. Klaproth, in analyzing gold ore from Schlangenberg in the Altai, found that it contained 64 parts gold, and 36 of silver; and Lampadius found in gold ore, whose locality was unknown to him, 96.6 parts of gold, and the remainder consisted of silver and iron. Mr. G. Rose, who accompanied Baron Humboldt into Siberia, made a collection of gold ores, for the express purpose of testing the position assumed by the French chemists. Gold ore is found in the Uralian mountains in rocks, and also scattered amongst sand; in which last situation it is now almost entirely sought after, being much less laborious than extracting it from rock veins. Its discovery in this situation occurred in 1819, since which period rock mines have been abandoned. The gold which is procured in rocks is universally found in quartz. At Beresow, it occurs in a crystallized form; at Newiansk, in plates; but at Czarewo Alexanderowsk, masses are met with which weigh from 18 to 96 lbs. troy. The proportions of gold and silver from the different localities vary considerably. The following are the extreme limits of this variation :—

	Silver.	Gold.
Hiel rock	87.40	12.60
Schaitansk	95.10	4.90

The following important consequences were deduced by Rose from his analysis. He remarked that gold and platinum were never found associated.

1. Gold ore does not contain gold and silver in definite proportions.
2. From the above fact, he infers that gold and silver are isomorphous.
3. Native gold always contains silver, copper, or iron. The smallest quantity of silver in combination, was in a specimen from Schabrouski, which contained only 16 per cent. of silver, while 35 per cent. of copper was found.
4. The specific gravity is in the inverse ratio of the proportion of silver contained in the ore. Gold obtained by fusion has a greater density than in a native state; but this may arise from cavities contained in the latter.
5. He found a difference in composition in specimens from the same locality.
6. Gold found in veins varies in different parts of the same mine.
7. Gold from sand contains more silver than that found in veins; that from sand being 89.7 per cent. of silver, and from veins, 79.1. [*Poggendorff, Ann.* xxviii., 566.]

The gold used in coinage and the arts is not the pure metal, but an alloy,—designed in the former case to correct its softness, and in the latter to adapt it to the various purposes of the goldsmith, and at the same time to reduce and regulate its value. An alloy with copper has a somewhat reddish hue; one with a small proportion of silver is pale-coloured; and one with silver, in the proportion of four parts of gold to one of silver, has a greenish hue. The entire mass of a gold alloy is supposed to consist of 24 parts or carats; and the proportion of gold contained in it, or the degree of fineness which it possesses, is expressed in figures which have reference to 24. Thus an alloy of 18 parts of gold and 6 parts of some other metal, is said to be 18 carats fine. The testing of the fineness of any specimen is usually effected by comparing a stroke or "touch" of it with strokes of small pieces of known composition on "a touchstone" of black basalt, flint, potter's-ware, or other similar material.

GOLDBACHIA. A small genus of ornamental plants, of the cruciferous order. The smooth-leaved species, *G. lævigatus*, is a hardy, pale blue-flowered annual, introduced about 20 years ago from Astracan. It has a close relationship to the radishes, and is called by some botanists *Raphanus lævigatus*.

GOLDEN EAGLE. See Eagle.

GOLDEN-HAIR. See Goldylocks.

GOLDEN-ROD,—botanically *Solidago*. A large genus of hardy, ornamental, perennial-rooted, yellow-flowered, herbaceous plants, of the thistle division of the composite order. Two species grow wild in Britain; nearly 50 species have been introduced from North America; and about a dozen species have been introduced from other countries. The species vary in height from a few inches to 8 or 10 feet; but most have a height of about 2 or 3 feet. All are somewhat coarse in appearance; yet the greater number, in consequence of their exhibiting long dense spikes of golden-coloured flowers, and possessing the habit of growing in firm and compact tufts in the same manner as the tall and stiff kinds of phloxes, constitute very appropriate and striking ornaments of the back parts of flower-borders, or the front parts of cottage shrubberies; and they boast the additional recommendation of blooming at the same time as dahlias, hollyhocks, sunflowers, tall phloxes, and some other open-ground, stalwart flowering plants. They grow freely in almost any sort of garden soil; and they may easily be propagated by the dividing of their roots late in autumn or early in spring; and some species spread with so great rapidity that they can readily endure a dividing of the roots every alternate year.

The common species, or golden-rod proper, or woundwort, *Solidago virgaurea*, grows wild in woods and thickets and other shady places in Britain, whether low or mountainous, fertile or heathy. Its root is ligneous, and has long, strong, simple fibres; its stem is usually from one to three feet high, somewhat crooked or inerect, purple-coloured in the lower part, and downy and terminating in a leafy cluster in the upper part; its leaves, especially on different varieties of the plant, are very various in size, form, and serrature; and its flowers, though always yellow and forming more or less of a long spike or compact panicle, are considerably varied in arrangement and appearance. Miller enumerates and describes four varieties of it under the notion of their being distinct species,—woundwort, with an erect stem, spear-shaped sawed leaves, and corymbous flowers on the side and at the top of the stem; woundwort, with an angular and almost flexible stem, and erect bunches of flowers in close panicles; woundwort, with linear-shaped and almost entire leaves, and with flowers in clusters sitting close at the wings of the stem; and woundwort, with a panicled stem, with oval and indented bottom-leaves, and with spear-shaped and entire stem-leaves. Two permanent varieties of the species also have been introduced to Britain from Switzerland and North America.

The whole plant of British woundwort, when bruised, emits an odour similar to that of carrots. It was formerly in much repute for healing wounds, both by external application and by inward administration; and it hence took to itself the name of woundwort, and entailed on the whole genus the name of solidago or "the uniter." An infusion of its leaves has sometimes been used as a beverage, in lieu of tea or coffee. Both its leaves and its flowers impart a beautiful yellow dye, and, but for the superior adaptation of imported dye-stuffs, might render the plant very worthy of field cultivation.

The other indigenous species, *Solidago cambrica*, has a very dwarfish habit, and is found, in its wild state, only on the mountains of Wales. Its stem attains a height of only about 6 inches; its lower leaves are narrow, lanceolate, 1½ inch long, smooth, slightly serrated on the edge, and a little hoary on their under surface; and its flowers are produced in roundish clustered spikes at the top of the stems, and are much larger than those of the common British species, and bloom 5 or 6 weeks earlier in the season.—Golden-rod is also the popular name of the small chenopodeous genus Bosea, and of a singular-looking species of the berberideous genus Leontia. See the articles BOSEA and LEONTICE.

GOLDEN-SAXIFRAGE,—botanically *Chrysosplenium*. A genus of low-growing, evergreen, herbaceous, yellow-flowered, ornamental plants, of the saxifrage tribe. Two species, the alternate-leaved, and the opposite-leaved, grow wild in moist shady woods, on marshy soils, on boggy grounds, and by the sides of shaded streams, in many parts of Britain; and both are only two or three inches high, and bloom in April and May, and have a sufficiently interesting appearance to deserve a place in the moist and shady corner of a garden. The alternate-leaved species has a fibrous and creeping root, angular and decumbent stems, reniform leaves, petiolate radical leaves, sessile and crowded stem leaves, and deep yellow corymbous flowers; and the opposite-leaved species differs from this principally in having smaller leaves, a paler verdure, and pale lemon yellow flowers. A pretty species was introduced nearly 30 years ago from Nepaul.

GOLDEN-THISTLE,—botanically *Scolymus*. A genus of ornamental, yellow-flowered, herbaceous plants, of the succory division of the composite order. One annual and two perennial rooted species, all about 3 or 4 feet high, have been introduced to our collections from countries bordering on the Mediterranean; but though interesting enough in a distant background or among botanical groups, they are too coarse to suit the ordinary flower-garden. The florets of one of the perennial-rooted species, *Scolymus Hispanicus*, introduced from the South of Europe about the middle of the 17th century, yield a yellow-coloured dye, and are often employed for adulterating the saffron yellow of the dyers.—Golden-thistle is the popular name also of a purple-flowered evergreen shrub of the protea genus, *P. Scolymus*, introduced about 60 years ago from the Cape of Good Hope.

GOLDEN SULPHURET OF ANTIMONY. A medicinal powder, of an orange-red colour, obtained by neutralizing an alkaline solution of sulphuret of antimony with an acid. The sulphuret is boiled in a solution of soda or potash: the Kermes mineral is separated from the solution by cooling; and the neutralizing acid is applied to the residue of the cold solution. "This preparation of antimony," says White, "is scarcely known to farriers, and I believe seldom used by veterinarians. It may be found useful, however, in obstinate diseases of the skin, either alone or joined with mercurials, such as calomel or sublimate. The dose is from one drachm to two; perhaps even more may be given with advantage; but it is advisable to begin with a small dose."

GOLDFINCH,—scientifically *Carduelis Elegans.* A well known song bird of the fringillidæ or finch family. It possesses very inferior powers of song, but is so surpassingly handsome and so exceedingly docile as to be one of the greatest favourites of almost all bird-fanciers. Its bill is whitish-brown, tipped with black; its forehead and chin are rich scarlet, divided by a line from the eyes to the corners of the bill; its eyes are dusky brown; its greater wing-coverts are bright gamboge yellow; and its body is wood-brown in the upper surface, and dull white in the lower parts. The tints of the male are more brilliant than those of the female; and the predominating colour of the young birds is brown. The goldfinch constantly resides in Britain; and abounds in many parts of France, Germany, and Italy; but does not appear to travel beyond the limits of Europe. "It gives preference," says Mr. Gould, "to high lands and mountainous districts during winter, particularly such as are wild and barren, and afford a plentiful supply of the thistle, plantain, &c., the seeds of which constitute its favourite food. At this period, it is generally to be observed congregated in small flocks, flying through the air, and suddenly settling among its favourite food. When the spring advances, and the trees display a verdant appearance, the goldfinch separates in pairs, each male taking a mate, and quitting the wild and open country for woods, orchards, and gardens, and, on the Continent, for the rows of fruit trees that border the road-side. As soon as the foliage becomes dense enough to conceal the nest, the task of incubation is commenced; the nest is placed in the fork of a branch, and is of the neatest construction, being composed of lichens, moss, and dried grasses, lined with hair, wool, and the seed-down of the willow and thistle; the eggs are four or five in number, of a bluish-white, spotted over with dashes of brown towards the larger end." The goldfinch has docility to learn and sagacity to practise and well-time many amusing little tricks, which recommend it to children and the curious; and it possesses such a habit of calling as renders it peculiarly adapted to serve as a bird-catcher's call-bird or decoy-bird. But many of the acquirements usually imposed by the training of bird-fanciers, are grossly inconsistent with good taste, and some even with right feeling.

GOLDFUSSIA. A genus of ornamental exotic plants, of the acanthus tribe. The unequal-leaved species, *Goldfussia anisophylla*, called by some botanists *Ruellia anisophylla*, by others *R. amygdalæfolia*, and by others *R. persicifolia*, is a beautiful evergreen tender shrub, of about 3 feet in height, of bushy habit, with smooth unequal leaves, and producing both very profusely and for a great length of time handsome pale bluish-white flowers; and it was introduced, about 24 years ago, to Britain from Silhet. The aggregate-flowered species, *Goldfussia glomerata*, was introduced a dozen or fourteen years later, and is nearly six times as large, considerably stronger and more luxuriant, and far larger in the size, as well as far intenser in the hue, of its very beautiful flowers; and it is characterized also by a prominent shaggy hairiness of both branches and leaves. Propagation is easily effected from cuttings; and cultivation, in the manner of ordinary stove plants. A number of other species are known.

GOLD OF PLEASURE. See CAMELINA.

GOLDYLOCKS,—botanically *Chrysocoma.* A genus of ornamental plants, of the thistle division of the composite order. Upwards of a dozen species have been introduced into British collections; and about twenty more are known. About one half of the introduced species are white-flowered or yellow-flowered evergreen shrubs, of from 3 to 6 or 7 feet in height, from the Cape of Good Hope; and the rest are hardy, perennial-rooted, herbaceous plants, of from 20 to 40 inches in height, and all with one exception yellow-flowered, from the northern temperate regions of both the old and the new world. The flax-leaved species, *Chrysocoma linosyris*, was the earliest introduced, and may serve as a specimen of the whole. Its root is perennial; its stem is herbaceous, annual, cylindrical, stiff, very leafy, and about 20 inches high; its leaves are long, narrow, smooth, and pale-green; and its flowers have a bright yellow colour, and stand disposed in a head, like an umbel, on many slender footstalks, growing from the upper part of the stem.

GOMPHIA. See BUTTON-FLOWER.

GOMPHOCARPUS. A small genus of ornamental, Cape-of-Good-Hope shrubs, of the swallow-wort tribe. The arborescent species, *G. arborescens*, was formerly regarded as a true swallow-wort, and has long been known in British collections. Its stem is erect and about 5 or 6 feet high; its leaves are long, narrow, pointed, and smooth; and its flowers are white, and are produced in loose umbels from the wings of the leaves, and bloom in the middle of winter. Two other but much smaller species occur in British collections.

GOMPHOLOBIUM. A genus of evergreen, undershrubby, ornamental, Australian plants, of the sophora division of the leguminous order. Upwards of twenty species, varying in height from 5 or 6 inches to 3 or 4 feet, have been introduced to the greenhouses of Britain. All are slender-growing, showy, and of great beauty; but the greater number are so exceedingly delicate as to require excessive care to bring them to tolerable perfection; yet a few are pretty generally diffused, and frequently furnish gorgeous specimens at the horticultural exhibitions. Some of the most esteemed are the multiform, the changeable, the bearded, the twiggy, the pedunculate, the netted, the woolly, the glaucescent, and the pinnate. The purple-stemmed variety of the changeable, *G. versicolor caulibus purpureis*, in particular, is both one of the chief beauties and one of the latest. It is an upright, twiggy shrub, somewhat inclined to grow tall and thin; but readily submits to pruning and training, and then assumes a more bushy habit, and becomes a very free flowerer. Its leaves are alternate and trifoliate; its leaflets are somewhat broadly linear; and its flowers are produced in double or treble, small, axillary racemes from the upper part of the branches, and are large, papilionaceous, and of a deep red colour. But the flowers of the vast majority of the genus have a yellow colour, and bloom in spring and summer. The soil proper for gompholobiums is sandy peat earth in a rough turfy state; and the most suitable treatment is potting in perfectly drained pots, watering carefully, regularly, and in very guarded quantities, shading from intense sun-heat in summer, exposing to the utmost possible light in winter, and maintaining as ample a ventilation as will possibly comport with protection from an injurious degree of cold. The name gompholobium alludes to the wedge-like shape of the pods.

GOMPHRENA. See GLOBE-AMARANTH.

GOMUTUS. An ornamental, economical, tropical, endogenous tree, of the palm family. It constitutes a genus of itself; and is specifically called *saccharifer* or "the sugar-bearer." Its usual height is about 40 or 50 feet. It was introduced to the palm-houses of Britain, nearly 30 years ago, from the Moluccas.

GONGYLUS. A kind of minute bud or "gem" in cryptogamous plants. It is a small globular granule, consisting externally of epidermis, and internally of indurated pulp; and is particularly exemplified in the fuci.

GONOLOBUS. A genus of curious and ornamental exotic plants, principally twining climbers, of the swallow-wort tribe. About 9 or 10 hardy or nearly hardy species, and 20 or 22 hothouse species, have been introduced to Britain; and most of the hardy species are deciduous, while most of the tender ones are evergreens. A considerable proportion are far from being showy, and have no better habit than rambling weeds; yet all are very singular in structure, differing from all other exogens, and possessing, in their parts of fructification, and particularly in their compact waxy masses of pollen, a near affinity to the orchidaceous order. All the hardy species are natives of North America; and most of the tender species are natives of tropical America. The usual height of the several species ranges from 3 to 14 feet; and the most common colours of their flowers are green and purple. Two of the least interesting kinds are *G. maritimus* and *G. diadematus;* and one of the most beautiful, and in all respects attractive, is *G. hispidus*. This last was introduced only a very few years ago from South Brazil. Its stem is shrubby, cylindrical, somewhat twining, and clothed with long, soft, yellowish, hispid hairs; its leaf-stalks are from ¼ to ½ an inch long, and clothed with hairs in a similar manner to the stem; its leaves are opposite, membranaceous, ovate, cordate, or orbicular, and of a pale green colour; and its flowers have a rotate, concave, coriaceous corolla, from ½ to ¾ of an inch in diameter, and of a shining dark brownish purple colour,—and are arranged in umbelled groups, each from 2 to 3 inches in diameter, and comprising 8 or 10 blossoms,—and are produced from the axils of the leaves, alternate on each side of the stem, at distances of about 3 inches,—and come out in such profusion as to begin about 18 inches from the ground, and continue to the height of several feet,—and have a powerful, agreeable, and very singular fragrance, smelling like a concentration of the flavour of roasted pease.

GOODENIA. A genus of ornamental, Australian plants, constituting the type of the natural order Goodenoviæ or Goodeniaceæ. This order is so nearly allied to the lobelia tribe as to be distinguishable from it only by a minute botanical character; and it may be regarded as occupying the same natural place in the southern hemisphere which the lobelia and the bell-flower families occupy in the northern hemisphere. About 20 greenhouse species and 3 or 4 hothouse species have been introduced to Britain; and these are distributed among five genera, and principally consist of yellow-flowered herbaceous or slightly ligneous plants. The genus goodenia itself comprises 7 or 8 of the introduced species; and at the same time includes about 25 additional and unintroduced species, known to botanists. All the introduced species of it are evergreens; the smallest is only a few inches high, and the tallest 4 or 5 feet high; one, the various-leaved, has pale-red flowers, and all the rest have yellow flowers; and all are handsome, while *G. gracilis* is eminently beautiful. The name goodenia was adopted in honour of Bishop Goodenough of Carlisle, and ought to have been goodenovia.

GOOD HENRY. See GOOSEFOOT.

GOODIA. A genus of evergreen, ornamental, yellow-flowered, Australian shrubs, of the broom and lotus division of the leguminous order. Three species have been introduced to British gardens; and the name of one of these, *G. lotifolia*, is frequently given by mistake also to *Cytisus tomentosus*.

GOODYERA. A genus of very beautiful, white-flowered, herbaceous plants, of the orchis family.

The creeping species, *G. repens*, called by some botanists *Neottia repens*, grows wild in the woods of some of the Scottish mountains. Its root is long, knotty, branched, woolly, and creeping; its stems or shoots attain a height of 9 or 10 inches; its leaves are ovate, smooth, about an inch long, and partially marked with brown,—and they grow in tufts of 6 or 8, on broad footstalks, at the top of the stems; and its flowers are small and fragrant, and grow in groups of 10 or 15 on spikes, and bloom in July and August. Four or five species, some evergreen and tender, others deciduous and hardy, have been brought from America and Nepaul; and some others are known.

GOOL. A ditch.

GOOSE. Those species of the goose genus which are generally known by the name of *ducks*, have been spoken of in the article Duck. The common goose, whose domestication is much less ancient and complete than that of the common hen, is the *Anser cinereus*, which, in its wild state, is grey, with an orange beak. Domestication has already induced innumerable varieties; this state has also greatly added to the fecundity of this bird. Three different broods can be obtained by taking away the first eggs and hatching them under a hen. None of our domestic birds are so apt to bring forth monstrous productions as geese—a circumstance which has been attributed to the excessive fatness to which they are liable. The liver of a fat goose is often larger than all the other viscera, and was a dish in so great reputation among the epicures of Rome, that Pliny thought it deserved a serious discussion, to whom the honour of inventing so excellent a dish was due. They fed their geese on figs, to improve their relish, and were not ignorant that they fattened sooner in a dark room; but it was left for modern gastronomers to invent the barbarous method of nailing down their feet and putting out their eyes.

GOOSEBERRY,—botanically *Ribes Grossularia*. A well-known British fruit-shrub, constituting the type of the natural order *Grossulaceæ*. See the article Ribes. This shrub is low, branching, and armed with prickles, and bears small rounded three to five lobed leaves and inconspicuous flowers. If not a native plant, it is at least completely naturalized in this country. It often appears in woods, and not unfrequently on the walls of ruinous buildings; but to these places the seeds no doubt have been carried by birds. The culture of this fruit has, for a number of years, been particularly attended to in the north-west of England; and the size and beauty of the Lancashire gooseberries have procured them the first character. In the south of Europe, we believe, the fruit is generally small and neglected; and when foreigners witness our Lancashire berries, they are ready to consider them as forming quite a different kind of fruit.

The varieties of the fruit are endless. They are distinguished by names not less sonorous, nor less fanciful and unmeaning, than those bestowed by the Dutch on their tulips and hyacinths. Many new ones are constantly coming into notice, and others are falling into neglect. They are classed according as their colours are red, green, yellow, or white. The names of a few of each of these, which are now or were recently in highest esteem, shall be mentioned.

Red.

Old Ironmonger,
Early Black,
Damson, or dark red,
Large Rough Red,
Red Walnut,
Warrington,
British Crown,
Smooth Red,
Hairy Red,
Red Champagne,
Nutmeg,
Captain,
Wilmot's early red,
Keen's Seedling.

Green.

Green Gascoigne,
Green Walnut,
White Smith,
Green Globe,
Green-gage,
Early Green Hairy.

Yellow.

Great Amber,
Globe Amber,
Great Mogul,
Hairy Globe,
Golden Drop,
Honeycomb,
Sulphur,
Conqueror,
Yellow Champagne,
Golden-knap,
Royal Sovereign,
Tawny.

White.

Large Crystal,
White-veined,
Royal George,
White Dutch,
White Walnut,
Sheba Queen,

It must be admitted, that although the large gooseberries make a fine appearance on the table, they are often deficient in flavour, when compared with some of smaller size. Many of them have very thick strong skins, and are not eatable unless thoroughly ripened. The gooseberry, it may scarcely be necessary to notice, is used not only for tarts, pies, and sauces or gooseberry creams, before being ripe; but, when at maturity, it forms a rich addition to the dessert for several months. Gathered unripe, gooseberries can be preserved in bottles against winter: the bottles are filled with berries, close corked, and well sealed; they are then placed in a cool cellar till wanted. By plunging the bottles after being corked into boiling water for a few minutes, (heating them gradually to prevent cracking,) the berries are said to keep better.

Gooseberry-bushes, like currants, are propagated chiefly by cuttings, preferring for this purpose clean and strong shoots of the former year, about a foot in length. They may be planted any time early in the spring. They are trained for two or three years, and should have a stem six or eight inches high. Strong suckers of straight growth are sometimes used, but they are considered as apt to produce suckers again. In many places little attention is paid either to the soil in which the gooseberry-tree is planted, or to its pruning and management: yet the fruit is greatly improved by attention to these circumstances. The best practical gardeners now prune the bushes so as to form them somewhat like a hollow sphere;

no main stem is encouraged, as was formerly done; but the centre is cut out, and eight or ten side branches preserved, according to the size of the plant. All water-shoots of the former season are removed; but any young shoots wanted for branches, are left at full length. In this mode of pruning or training, the stem may be short, perhaps half a foot, instead of a whole foot. The bushes may also be planted nearer to each other than such as are allowed to rise many feet in height. They should not however be less than five or six feet asunder in every direction, the free admission of light and air being quite necessary. If the bushes be attended to in the month of June, and all central water-shoots and suckers be displaced, the additional light and air thus admitted will be found very beneficial to the fruit, while the labour of winter pruning will be at the same time diminished. In many gardens gooseberry-bushes are still placed in single rows along the sides of borders; but this is not so good a plan as having a separate quarter for them. They may be planted in November, or any time before February; and the plantation should be renewed every seven or eight years.

If some of the late yellow sorts be matted in September, they remain good till November. A few plants of the finer kinds are sometimes trained against a south or east wall; here the fruit not only comes earlier, but attains greater size than usual. They also do very well on a low espalier-rail. In some places, gooseberry-trees on the sides of the borders, are trained to a single tall stem, which is tied to a stake: this, though six or eight feet high, occasions scarcely any shade on the border, and it does not occupy much room, nor exclude air; while at the same time the stem becomes closely hung with berries, and makes a pleasant appearance in that state. Some sorts of gooseberry-bushes, and those producing the largest fruit, have a natural tendency to bend their branches downwards. In this case the branches must be supported with small forked sticks, in order to admit air, and to save the fruit from touching the ground.

GOOSE-CORN. The squarrose rush, *Juncus squarrosus*, inhabiting the sandy heaths of Britain. See the article Rush.

GOOSEFOOT,—botanically *Chenopodium*. A genus of plants, principally green-flowered annual weeds, constituting the type of the natural order Chenopodeæ or Chenopodiaceæ. This order is so nearly allied to the amaranth tribe as to be distinguishable from it rather by habit than by any proper character. Very nearly all its plants, excepting those of a single genus, are ill-looking weeds; and some have also a very disagreeable smell. But though almost as ugly as the amaranthaceæ are beautiful, they far excel that order in economical value. A large number abound in alkaline secretions, and are capable of yielding considerable quantities of alkali to the manufacturer; some possess antispasmodic and tonic properties; several produce a large quantity of sugar; two or three act as emetics or anthelmintics; and a few are valuable, in either their roots, their leaves, or their seeds, as food to both the lower animals and man. The species within Britain, whether indigenous or exotic, amount to about 200; and upwards of three-fourths of these are hardy herbs. The number of genera is upwards of 20; and the most remarkable are *beta*, *chenopodium*, *salsola*, *salicornia*, *blitum*, and *atriplex*.

The genus chenopodium comprises 13 indigenous species, about 20 introduced exotic species, and about 40 unintroduced known exotic species. Good Henry or mercury goosefoot, *C. Bonus Henricus*, is a herbaceous evergreen, and grows wild among rubbish, on waste ground, by the sides of roads, and occasionally in pastures. Its root is fleshy and branching; its stem is dark green, almost smooth, and about a foot high; and its flowers are produced in a spike or compound cluster at the top of the stem, and are numerous and green, and bloom from May till August. This plant is eaten in its young state as a substitute for spinach, and is cultivated as an esculent in some parts of the east of England; yet it is always insipid and unsatisfying, and speedily becomes fibrous and tough, and it is disliked by cattle, by hogs, by sheep, and even by goats.

The standing or rank-smelling goosefoot, *C. olidum*, is an annual weed of rubbishy or sandy spots on the sea-board districts of Britain. It attains a height of about a foot; it has a dull greyish-green colour, and is covered with a mealy and greasy secretion, and, when touched, emits a strong, enduring, and very disagreeable odour, similar to that of putrid salt fish; and yet, it is eaten by goats, sheep, cattle, and horses. This plant was anciently in great repute as an emmenagogue, and has still considerable reputation in that capacity. It has been recently recommended, also, for its uterine action in a similar manner to ergot; and is given, for this purpose, in doses of from 5 to 15 grains of its inspissated juice or extract at bed-time; but it fully succeeds only in the pale or cachectic patient, and does not take effect upon a plethoric habit unless previously reduced by venesection and saline purgatives.

The sea goosefoot, sea-blite, or small glasswort, *C. maritimum*, abounds on the sea-shores and the salt-marshes of Britain, and grows also in sandy and muddy spots so situated as to yield materials for saline secretion. Its root is annual; its stem is thick, juicy, and about 3 feet high; its leaves are smooth, of a light bright green colour, of a saltish taste, and each about an inch in length; and its flowers are green, and appear in August. This plant has been recommended as a very good pot-herb; it is used in various parts of Asiatic Russia for yielding alkaline matter, to serve the same purposes as our potash; and, but for the greater cheapness and facility of other materials, it might well enough be employed in Britain to yield alkali for the manufacture of glass.

The white goosefoot, or fat hen, or common wild orache, *C. album*, is an abundant annual weed of many kinds of situations and grounds in Britain, but particularly of waste spots and heaps of rubbish. It has a mealy appearance, and is covered with a silvery greasy pubescence, which gives it a fattish kind of character, but, in the latter part of the season, becomes dry and chaffy. Its stem is usually about 20 inches high; and its flowers are green, and bloom from July till September; but its other parts, especially its leaves, exhibit such marked and permanent differences as to occasion the distribution of the species into several varieties. One variety, *C. a. viride*, has a predominantly green colour; another, *C. a. subrotundum*, has roundish leaves; another, *C. a. integrifolium*, has entire leaves; and another, *C. a. crassifolium*, has thick and somewhat fleshy leaves. This plant is eaten by sheep and cattle, and greedily devoured by swine.

The city goosefoot, *C. urbicum*, is a weed of British dunghills, and of spots of waste ground and rubbish. It is about a foot high, and blooms in August.—The red goosefoot, *C. rubrum*, is also a weed of dunghills and waste grounds. It occurs most commonly in low muddy situations; but is found also in exposed situations; and, in the latter case, it usually possesses a reddish colour. Its stem is about two feet high; and its flowers are red, and bloom in autumn. This plant is supposed to be poisonous to swine.—The wall goosefoot *C. murale*, has a stem of about 20 inches high, and green-coloured flowers; and it grows on rubbish, and blooms in autumn.—The fig-leaved goosefoot, *C. ficifolium*, is about two feet high, and grows on dunghills, particularly in the vicinity of London.—The botrys-like or many-spiked goosefoot, *C. botryoides*, is about a foot high, grows on the sea-shore, and blooms from June till August.—The glaucous or oak-leaved goose-foot, *C. glaucum*, grows on rubbishy places with a sandy soil in England, but does not occur in Scotland. Its stem varies in height from 2 or 3 inches to 2 feet; and its flowers are green, and bloom in July and August.—The many-seeded goosefoot, or round-leaved goosefoot, or all-seed goosefoot, or upright blite, *C. polyspermum*, grows on rubbishy spots in both Scotland and England. It is about a foot high, and blooms in July and August. Its appearance is curious; and its numerous, black shining seeds might possibly be worth gathering for the feeding and fattening of poultry.—The acute-leaved or sharp entire-leaved goosefoot, *C. acutifolium*, inhabits various kinds of uncultivated ground, has a height of about a foot, and blooms in July and August.—All the species which we have now noticed, excepting the Good Henry, are annuals.

The shrubby goosefoot, *C. fruticosum*, ranked by some botanists as a saltwort, and called *Salsola fruticosa*, grows wild on the sea-shores of England, but is far from being common. It is a small evergreen shrub, possesses a somewhat ornamental character, and, but for the cheap and facile methods in which the alkalies of commerce are now obtained, might be cultivated in the fields of maritime districts as an economical plant. Its stem is between 2 and 3 feet high, and sends out many upright leafy branches; its leaves are alternate and small, and contain a very perceptible amount of alkaline secretion, and have a somewhat acrid taste; and its flowers are green, but have yellow anthers, and bloom in August and September. This plant deserves a place in shrubberies, maintains its pleasing appearance for many years, and requires scarcely any care for its proper cultivation.

The quinoa goosefoot, or simply quinoa, *Chenopodium Quinoa*, is an annual plant, both wild and cultivated, of Peru and Mexico, and has been recommended for cultivation in Great Britain. A figure of it is represented in *Plate XXI.*

"Humboldt," says Loudon's Gardener's Magazine in December 1834, "states that this plant, in Mexico, ranks in utility with the potato, the maize, and the wheat. The leaves are used as spinach or sorrel, or as greens; and the seeds in soups or broth, or as rice. Throughout great part of South America, and especially in Peru, the seeds are in as common use as rice is in Hindostan. The seeds are considered more heating than rice; and on that account, they are frequently given to domestic poultry to make them lay early. The plant, in general appearance, resembles the *Atriplex hortensis* or French spinach; and, under the same circumstances of soil, climate, &c., will grow to about the same height as that plant. The seeds are small, yellowish-white, round, somewhat flattened, about a line in diameter, and, on a cursory glance, might be mistaken for those of millet. Mixed with the latter seeds and fermented, a pleasant kind of beer is said to be produced. They are contained in a single envelope, from which they are very easily separated. The quinoa was first introduced into England in 1822; and it has ripened seeds at Kew. No particular notice, however, appears to have been taken of the plant till this season, when it has been grown by A. B. Lambert, Esq., at Boyton, where it has ripened abundance of seeds on plants varying from 3 feet to 7 feet in height. To do any good in producing nutritious seeds, the plant should be subjected to field culture, in which we see not the slightest difficulty. It might be sown very thinly in drills, 3 feet apart, at about the same season as barley, and the plants afterwards thinned to the distance of one foot apart. There appears, at present, no reason whatever why it should not become as common in the fields of Europe as barley, wherever that grain can be cultivated. Dombey, the botanical traveller, on his return from Peru, was lavish in the praise of the quinoa as a valuable esculent, and took great pains to naturalize it in France; but the seeds which he brought with him failed."

Don Antonia de Ulloa, the old Spanish voyager, when giving, in his work on South America, an account of the vegetable productions of Quito, says, "Besides the grains of the same species with those in Spain, this country has one peculiar to itself, and which very well deserves to be ranked among the most palatable foods; but still more valuable, from its being one of the best preservatives against all kinds of abscesses and imposthumes. This useful species of grain is here called quinoa, resembles a lentile in shape, but much less, and very white; when boiled, it opens, and out comes a spiral fibre, which appears like a small worm, but whiter than the husk of the grain. It is an annual plant, being sowed and reaped every year. The stem is about three or four feet in height, and has a large pointed leaf, something like that of the Malloro. The flower is of a deep red, and five or six inches in length, and in it are contained the grains, or seed. The quinoa is eaten boiled, like rice, and has a very pleasant taste, and the water in which it has been boiled is often used as an apozem. The quinoa is often used in external applications, in order to which, it is ground and boiled to a proper consistence; after which, it is applied to the part, from which it soon extracts all corrupt humours occasioned by a contusion." Dr. Tschudi, the recent German traveller, says, in his interesting work on South America, "Maize is the species of grain most extensively cultivated in the Sierra; it is of excellent quality, though smaller than that grown on the coast. Wheat, though it thrives well, is cultivated only in a very limited quantity, and the bread made from it is exceedingly bad. The other species of European grain, barley excepted, are unknown to the Serranos. To compensate for the want of them, they have the quinoa, which is at once a nutritious, wholesome, and pleasant article of food. The leaves of this plant, before it attains full maturity, are eaten like spinach; but it is the seeds which are generally used for food. They are prepared in a variety of ways, but most frequently boiled in milk or broth, and sometimes cooked with cheese and Spanish pepper. The dried stems of the quinoa are used as fuel. Experiments in the cultivation of this plant have been tried in some parts of Germany, and with considerable success. It would appear, however, that its flavour is not much liked,—a circumstance rather surprising to the traveller, who has tasted it in Peru, where it is regarded in the light of a delicacy."

About fifty plants of quinoa were raised in one of the Edinburgh nurseries, in 1835, from a sowing about the end of April; and they atained a height of about 4 feet, had short and compact branches, bore a profusion of succulent foliage, of similar properties to spinach, ripened in the first week of October, and yielded a quantity of available seed which, when dried, weighed 4 lb. 2 oz.—A variety of this species, called red quinoa, *C. q. rubrum*, differs so widely from the normal plant or white variety as almost to seem a totally distinct species. Its stem attains a height of 6 or 8 feet, or even more; its branches are numerous, long, and spreading; and its foliage, though similar in succulency to that of the white variety, is much more abundant. But plants of it raised in the Edinburgh experiment simultaneously with those of the white variety advanced so slowly to maturity, that, on the 12th of November, most of the flowers were in full bloom, and only a few seeds were even partially formed. The red variety, therefore, for any purposes of seeding, would seem to be entirely unadapted to Scotland, or even very probably to the south of England. The report of the Royal Dublin Society's Botanic Garden, for November 1841, says, "The quinoa, a plant from the table-land of Mexico, (where it is used for feeding poultry, and the inhabitants of that country, in much the same way as rice is used in other parts of the world,) has ripened plenty of seeds, and any person desirous of trying it, for poultry feeding, may be supplied." In a recent number of the Gardeners' Chronicle, Dr. Lindley recommends a trial of quinoa.

GOOSEFOOT,—botanically *Aspalathus Chenopoda*. A beautiful, yellow-flowered, evergreen, Cape-of-Good-Hope shrub, of the broom division of the leguminous order. It grows about a yard high, and blooms in July and August. It was introduced to Britain about 90 years ago.

GOOSEGRASS. The climbing species of bedstraw, called popularly cleavers, and botanically *Galeum aparine*.

GOOSE TANSY,—botanically *Potentilla Anserina*. A perennial-rooted herbaceous weed, of the same genus as the common creeping cinquefoil. It inhabits moist meadows and similar situations, has a height of 9 or 10 inches, and carries yellow flowers from May till September. See the articles CINQUEFOIL and POTENTILLA.

GORDONIA. A genus of sub-evergreen plants belonging to the natural order Ternstrœmiaceæ, so named in honour of Alexander Gordon, a celebrated nurseryman, at Mile End near London, in the time of Philip Miller. The *G. lasianthus*, or woolly-flowered Gordonia, was introduced into England in 1768; but it has never been very successfully cultivated. The leaves are from 3 to 6 inches in length, alternate, slightly toothed, and smooth and shining on the upper surface. The flowers are white and sweet-scented. The *G. pubescens* is a smaller species, bearing flowers nearly 3 inches in diameter, with yellow anthers.

GORSE. See FURZE.

GORTERIA. A small genus of plants, of the sunflower division of the composite order. The mask species, *G. personata*, was introduced, upwards of 70 years ago, from the Cape of Good Hope to Britain; and is a yellow-flowered ornamental annual, of 6 or 8 inches in height.

GOSHAWK,—scientifically *Aster Palumbarius.* A beautiful and high-spirited bird, of the hawk group and raptorial order. It is rare in Britain, but abounds more or less throughout the greater part of continental Europe. It was formerly in great request among falconers, for assailing partridges, grouse, pheasants, hares, and rabbits; and it is still occasionally used for hawking. It frequents the most sequestered recesses of forests, builds its nest on the fir-tree or on some other lofty tree, and feeds upon hares, squirrels, and the large or middle-sized kinds of wild birds. It flies lowly and rapidly, darts skimmingly along in quest or pursuit of prey, and assails its victim with comparatively prodigious force. A full-grown one can easily secure a hare. The male is about 19 or 20 inches long, and the female about 24; and both are distinguished by great beauty and elegance. The greater part of the plumage is greyish-brown; the throat, the breast, the belly, and the thighs have a predominant whitish colour, with bars, markings, and waving lines of black; the legs and toes are yellow; and the claws are black.

"The habits and mode of flight of goshawks," says a writer in the Magazine of Natural History, "are much better suited to an enclosed district than those of the peregrine falcon. When used or taken into the field, the wing of a bird or the thin end of an ox-tail is generally held in the hand to engage their attention, which they are constantly biting and tearing without being able to satisfy their appetites, as that would render them unfit for work. They do not require to be hooded, but have bells attached to the legs for the purpose of giving notice of their situation when they alight (which would otherwise be difficult to ascertain), and a leathern strap by which they are held; it is also necessary to have spaniels to hunt up the birds, upon the appearance of which the hawk flies from the hand with incredible swiftness direct at the game, generally taking it at the first attempt; but should the hawk fail, it will perch on some elevated situation, and remain until the game is again started, and is rarely known to miss a second time. When the hawk has captured the game, he is rewarded with a small piece of meat or a pigeon's head, to induce him to give up his prey. If the hawk be allowed to range at pleasure, by whistling it will return with a swiftness truly astonishing; and, finding it cannot stop suddenly to settle without striking you with great force, it will glide past, form a circle round you, and alight with the greatest ease and in the most gentle manner upon the hand." See the article Hawk.

GOSSYPIUM. See Cotton.

GOUANIA. A genus of ornamental, evergreen, climbing, tropical plants, of the buckthorn tribe. Six or seven species have been introduced to British hothouses; and about 15 other species are known. All the introduced species attain a height of about 10 or 12 feet, and have green or greenish-yellow flowers.

GOUFFEIA. A genus of ornamental plants, of the carnation tribe. The holosteum-like species, *G. holosteoides*, is a hardy, white-flowered annual, of about 2 feet in height, and capable of blooming from June till August; and it was introduced to Britain, in 1836, from Russia.

GOULARD'S EXTRACT,—scientifically *Triacetate of Lead.* A medicinal preparation, of much note for the reduction of external inflammations. It was formerly called subacetate of lead and extract of saturn. A defective variety of it is prepared simply by simmering vinegar and litharge together over a slow fire till the vinegar becomes completely saturated with the litharge; but the proper variety is prepared by boiling one part of acetate of lead, or, as it was formerly called, sugar of lead, and two parts of litharge, deprived by heat of carbonic acid, with 25 parts of water. The result is a liquid alkaline salt, sweeter and more soluble than acetate of lead; and this salt is the genuine extract; and, though very difficult of crystallization, may, with great care, be obtained by evaporation in the form of white tabular crystals. The extract, in consequence partly of the easy preparation of the bad variety, and partly of the difficult crystallization of any variety, is known in pharmacy only as a liquid; and it is used, in veterinary practice, in the form of either a lotion or a poultice. A proper lotion of it for the eyes is a mixture of half an ounce of it with at least a quart of water; and a proper one for any other part is a mixture of it with either a pint of water alone, or with also a little camphorated spirit or some distilled vinegar. A poultice is made by mixing as much of the lotion with bran, linseed-meal, or any similar material, as will give it the requisite consistence. The extract is never given internally, or used undiluted.

GOURD,—botanically *Cucurbita.* A genus of succulent, creeping, large-fruited, annual plants, constituting the type of the natural order Cucurbitaceæ. About 50 hardy species and nearly 100 tender species of this order occur in the gardens and botanical collections of Britain; and these are distributed into 18 genera,—the most remarkable of which are cucurbita, cucumis, bryonia, elaterium, and momordica. The fruit of the greater number is watery, pulpy, sweet, agreeable, and refreshing; and possesses great and benign adaptation to the daily wants of men in tropical climates. The fruit of the colocynth gourd and two or three others is drastically purgative; and the roots of several, particularly of the bryonies, are also powerfully medicinal.

The pumpkin, pumpion, or more correctly pompion, is the fruit of the *Cucurbita pepo* of Linnæus, introduced to England from the Levant in 1570. The pumpkin was the melon or millon of our early horticulturists, the true melon being formerly distinguished by the name of Musk-melon. The pumpkin is now cultivated principally for ornament or curiosity; but in some of the villages of England, the country people plant it on dunghills, at the back of their houses, and train the shoots to a great length over grass. When the fruit is ripe, they cut a hole on one side, and having taken out the seeds, fill the void space with sliced apples, adding a little sugar and spice, and then bake the whole.

The water-melon, or citrul,—the fruit of the *Cucurbita citrullus* of Linnæus, now regarded by many botanists as a cucumber, and called *Cucumis citrullus*—although it forms both the food and the drink of the inhabitants of Egypt for several months in the year, is little regarded in Britain. It requires the same attention and expense as the common melon; the hot-beds and glass frames, indeed, would need to be even of a larger size. In a few places only, two or three plants of the water-melon are occasionally cultivated with such attention as to procure the ripe fruit. See the article CUCUMBER.

The squash and the warted gourd, the fruits of the *C. melopepo* and *C. verrucosa*, though commonly cultivated as esculents in North America, are considered in this country only as curiosities. In the same way are viewed the orange-gourd, *C. aurantia*, which is really ornamental, when trained spirally round a pole, or against a wall, and loaded with its yellow fruit; and the bottle-gourd or false calabash, which is now erected into a separate genus, and challenges the revived attention of the British cultivator. See the article LAGENARIA.

The succada, or vegetable marrow, is a kind of small green gourd lately introduced. It is raised under a hand-glass, and afterwards transplanted into a good aspect, and trained to a trellis. When the fruit is of the size of a hen's egg, it is dressed in salt and water, squeezed, and served up in slices on a toast.

GOURD (SOUR). See ADANSONIA.

GOUTWEED. See GOATFOOT.

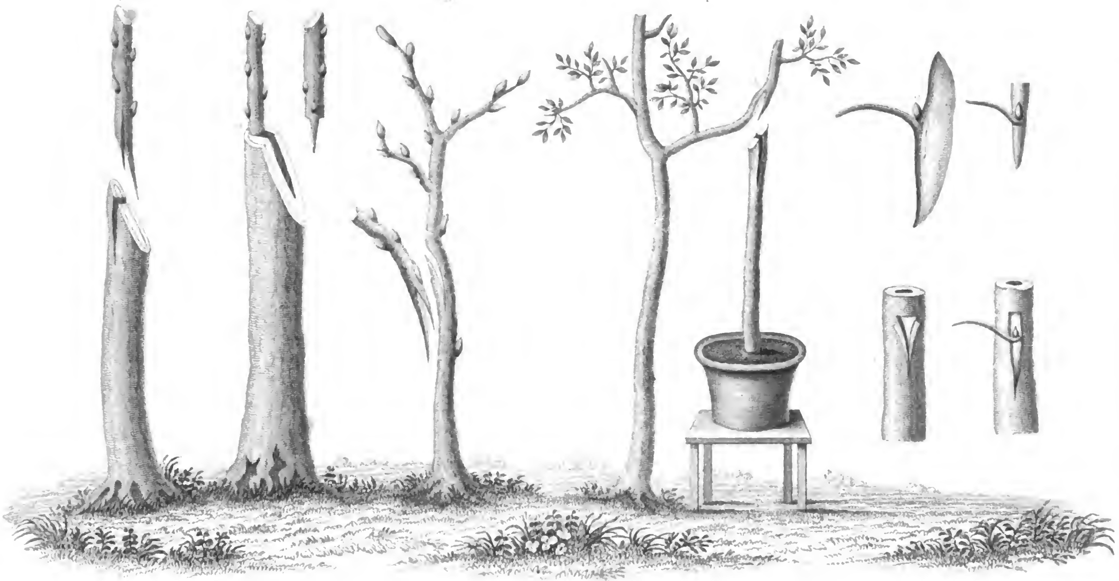
GOVENIA. A recently discovered genus of magnificently flowering plants, of the orchis tribe. An evergreen herbaceous species, *G. superba*, closely allied in character to the maxillarias, was introduced to Britain from Mexico in 1825; and this grows 5 or 6 feet high, has orange-coloured flowers, and blooms in the end of winter and beginning of spring. Another very handsome species, but with tuberous root, lily-looking flowers, a stem of only about a foot in height, and a habit of blooming at an advanced period of summer, *G. liliacea*, was introduced in 1837.

GRABOWSKIA. A spiny, scrambling, South American shrub, of the nightshade family. It was discovered by Sellow growing as a common shrub, from 6 to 10 feet high, in the fields and woods of the southern provinces of Brazil; and though regarded by some botanists as a lycium, and by others as an ehretia, it really revealed, in its drupaceous fruit, a connecting-link between the common nightshades and the nolanas, and was properly constituted the type of a new genus, with the jaw-breaking specific name of Boerhaaviæfolia. Its leaves are fleshy and glaucous, have a greyish colour and a singular appearance, and produce a similar effect upon the observer to the foliage of *Atriplex halimus*; its flowers are axillary, and have a fleshy calyx, and a pale leaden-blue corolla; and its fruit is dicarpellary, with the carpels posterior and anterior. The plant is hardy enough to grow in the open air, against a south wall, in the south or even centre of England; and in spite of the dull aspect of both its leaves and its flowers, it makes a pleasing appearance when mixed with other and greener plants.

GRAFTING. The act of inserting a shoot or scion, taken from one tree, into the stem of another, in such a manner that they unite, and the inserted scion bears its own fruit.

Grafting may be performed in several different ways. The most important points are, to apply the inner bark of the stock and of the graft precisely to each other, and to bind them firmly in that situation. M. Thouin of Paris, in his laboured but excellent papers in the 'Memoires du Museum d'Histoire Naturelle,' has made many minute distinctions, enumerating and describing no fewer than forty modes of grafting, independent altogether of several modes of grafting by approach, and of budding. We shall content ourselves, however, with explaining only the principal kinds practised by our own gardeners. These, as well as several other sorts of grafting, are very distinctly described, and illustrated by figures, by the late Mr. Curtis, in his Lectures, vol. iii.

The mode of grafting most commonly adopted in forming young fruit-trees is called *tongue grafting*. Here it is desirable that the top of the stock, and the extremity of the graft, should be nearly of equal diameter. Both are cut off obliquely, at corresponding angles, as nearly as the eye can guess; and the tip of the stock is cut off horizontally. A slip, or very narrow angular opening made by cutting out a thin piece, is then made in the centre of the stock downwards, and a similar slip in the graft upwards. *Plate XXIII, Fig.* 1. A very sharp and narrow-bladed knife is necessary. The thin point of the upper half of the sloping end of the graft is then inserted into the slip in the stock; this is sometimes called *lipping*. The barks of stock and graft are brought closely to unite, at least on the right hand side, so as not to be displaced in tying, which is always done from left to right, or in the course of the sun. Strands of fresh bass-matting, steeped for a little time in water to render them more pliant, and to prevent the knot from slipping, are generally used for ties. A quantity of clay is worked fine, and mixed with some hay chopped small, or horse droppings, and sometimes with a little salt



It is found better to have it prepared a day or two beforehand, and to beat it up with a little water as needed. The tying is then covered with this clay, in the form of a collar, or ball tapering at both ends, the upper end being applied closely to the graft, and the under to the stock. These balls are not removed till after midsummer. A neat substitute for clay is mentioned by Abercrombie: a composition of turpentine, bees' wax, and rosin, at first melted together, and afterwards heated as wanted; care being taken not to apply it too hot. A coating, laid on with a brush, to the depth of a quarter of an inch, is said to be less liable to crack than clay; and, it is added, that when the full heat of summer arrives, the composition melts away of its own accord. It may be remarked, that the *whip grafting* mentioned in old horticultural books, is merely the kind now described, wanting the important improvement of the tongues or lips.

When the stocks to be grafted upon are strong, or perhaps branches of large trees, *cleft grafting* is often resorted to. The head of the stock or branch, which we may suppose to be two or three inches in diameter, is first cut off obliquely, and then the sloped part is cut over horizontally near the middle of the slope; a cleft, nearly two inches long, is made with a stout knife or thin chisel in the crown downwards, at right angles to the sloped part, taking care not to divide the pith. This cleft is kept open with the knife. (*Plate XXIII. Fig.* 2. *a.*) The graft has its extremity for about an inch and a half cut into the form of a wedge, (*Fig.* 2. *b.*); it is left about the eighth of an inch thick on the outer or bark side, and is brought to a fine edge on the inside. It is then inserted into the opening prepared for it; and the knife being withdrawn, the stock closes firmly upon it. A circular incision is now made in the bark of the stock at the base of the wedge, to the extent of three parts of the circumference of the stock; by this means a shoulder can be formed on each side of the cleft.

Old stocks are sometimes grafted in another way, called *grafting in the bark* or *rind*, or *crown grafting*. The head of the stock or thick branch is cut off horizontally; a perpendicular slit is made as in budding; a narrow ivory folder, or a silver fruit-knife, is thrust down between the wood and the bark, at the places where the grafts are to be inserted. The graft is cut, at the distance of an inch and a half from its extremity, circularly through the bark, not deeper than the bark on one side, but fully half way through, or beyond the pith, on the other. The cut portion is then sliced away; the end of the graft is pointed, being sloped a little to the point on the outside, but left straight on the inside. A shoulder is likewise left, to rest on the bark of the stock. The grafts are then inserted into the openings made by the ivory folder; and either three or four grafts are inserted on a crown, according to its size. This mode cannot be practised till the sap be in full motion, perhaps in the end of March, as till then the bark cannot easily be raised from the wood. When the grafts are placed on old trunks, they are apt to be drawn from their places by violent winds; it is proper, therefore, to bind them to stakes for the space of perhaps two years, when they will have acquired a sufficient hold of the stock.

Saddle grafting consists in cutting the top of the stock into a wedge-like form, and in making a corresponding angular notch in the bottom of the graft, to fit the wedge like a saddle. It is a mode sometimes adopted in the grafting of orange trees.

Side grafting is merely tongue grafting, performed in the side of a branch, or in the body of a stock, without heading down. The bark, and a little of the wood, are sloped off for the space of an inch and a half, or two inches; a slit is then made downwards, and the graft is cut to fit the part, with a tongue for the slit, (*Plate XXIII. Fig.* 3.); the parts being properly joined, are tied close, and clayed over. This mode is sometimes employed for supplying vacancies on the lower parts of full grown fruit-trees. It cannot properly be performed till the sap is in action, or till about the middle of March.

Grafting by approach, *inarching*, or *ablactation* as the older horticulturists termed it, is practised on some kinds of fruit-trees, chiefly tender, such as oranges, lemons, pomegranates, and mulberries, and on several ornamental trees which do not readily succeed by the ordinary means, such as myrtles, jasmines, andrachnes, and some rare species of oaks, firs, and pines. Walnut trees are sometimes also increased in this way. The principle is, that the graft shall continue to have a degree of attachment to the parent plant sufficient to keep it alive, until such time as its bark shall have become united to the bark of the stock which is approached to it. The stock is often planted in a pot (*Plate XXIII. Fig.* 4. *a.*) at least a year before, and is brought close to the tree or shrub to be grafted on it, (*Fig.* 4. *b.*); if too low, it is raised on a slight stage to the required height. Where the tree is strong, the pot is sometimes fixed upon one of the branches of the tree. The operation of inarching is seldom performed before the middle of April, or the beginning of May. When it can be accomplished, tongue grafting is even in this way advisable. In four or five months the inarched graft is generally found to be fairly united to the stock; the head of the stock is then cut off; but the graft is not separated from the parent plant till nearly a year has elapsed. Sometimes, for sake of curiosity, branches of contiguous trees are joined by approach-grafting. To make this experiment succeed, it is necessary to fix the branches to poles, to prevent wind-waving; and indeed this caution is in general necessary in all kinds of inarching practised in the open air.

Recourse is sometimes had to *root-grafting*, either for curiosity, or on account of seedling stocks being scarce. A piece of the root of a tree of the same genus, well furnished with fibres, is selected, and a graft placed on it, tied and clayed in the ordinary way. Thus united, they are set with care in a trench in the ground, the joining being covered, but the top of the graft being left two inches above the ground. Some gardeners have thought that in this way the plant must preserve a nearer resemblance to the parent-tree; but Abercrombie remarks, that though it is an expeditious way of obtaining a new plant, such a graft cannot be materially different from a cutting or layer.

What is called *shoulder* or *cheek grafting*, was formerly much more frequently employed than it is now. The head of the stock being first cut off horizontally, one side of it is then sloped. The graft is sloped in the same manner, and a shoulder left at the point where the sloping begins. This shoulder is applied to the horizontal head of the stock, and the bark is brought to join at each edge if possible. Another old method of grafting was called *terebration* or *peg-grafting;* the head of the stock was cut off horizontally, and a hole was bored in the centre of it; the graft was selected of equal bole with the stock; within an inch and a half of the lower end of the graft, a circular incision was made, and the bark and a great part of the wood were removed, leaving only a peg to fit the hole bored in the stock.

The *scions* are gathered a good many weeks before the season for grafting arrives: the reason is, that experience has shown, that grafting may most successfully be performed, by allowing the stock to have some advantage over the graft in forwardness of vegetation. It is desirable that the sap of the stock should be in brisk motion at the time of grafting; but by this time, the buds of the scion, if left on the parent tree, would be equally advanced; whereas the scions, being gathered early, the buds are kept back, and ready only to swell out when the graft is placed on the stock. Scions of pears, plums, and cherries, are collected in the end of January or beginning of February. They are kept at full length, sunk in dry earth, and out of the reach of frost, till wanted, which is some time from the middle of February to the middle of March. Scions of apples are collected any time in February, and put on from the middle to the end of March. The selecting of proper scions is a matter of the greatest importance, if we wish to enjoy the full advantage which may be derived from grafting. They should be taken from a healthy tree in full bearing, and from the outer side of the horizontal branches of such a tree, where the wood has freely enjoyed the benefit of sun and air. It is however the observation of a judicious practical gardener, that particular notice should be taken, whether the tree to be grafted from be in a luxuriant or in a debilitated state. If the former be its condition, the grafts are very properly taken from the extremities of bearing branches; but if it be in the latter predicament, the most healthy shoots in the centre of the tree should be resorted to; and if no proper shoots exist, the amputation of some central branches will quickly tend to produce them. The least reflection must convince every one, how extremely improper it must be to take scions from young trees in the nursery lines, as is too often done. It may be remarked, that the middle of the scion generally affords the best graft.

In former ages of the world, it was supposed that grafting, the origin of which is hid in the obscurity of antiquity, could be performed between every species of tree and shrub. Roses, it was said, became black when grafted on black currants, and oranges crimson if worked on the pomegranate. But the operation is never successful unless the graft and stock are nearly allied, and the greater the affinity the more certain the success. "Varieties of the same species unite most freely, then species of the same genus, then genera of the same natural order; beyond which the power does not extend. For instance, pears work freely upon pears, very well on quinces, less willingly on apples or thorns, and not at all upon plums or cherries; while the lilac will take on the ash, and the olive on the Phillyrea, because they are plants of the same natural order. M. Decandolle even says that he has succeeded, notwithstanding the great difference in their vegetation, to work the lilac on the Phillyrea, the olive on the ash, and the Bignonia radicans on the Catalpa (in all cases of the same natural order); but plants so obtained are very short-lived." There are however some exceptions to this rule. Thus, the cultivated cherry, and most species of wild cherry, though of the same genus, will not agree. The pear succeeds better on the quince than on the apple, although the apple and pear are within the same genus, and the pear and quince are by most regarded as of distinct genera; the superior firmness of the wood of the quince, a quality so important to successful grafting, more than making up the difference in affinity. Lindley mentions also some exceptions which are apparent only. In one case, the fig was supposed to grow on the olive. But the graft, being below the surface of the soil, rooted in it, independently of the fig stock. Pliny speaks of a tree grafted to bear, on the same stem, pears, apples, figs, plums, olives, almonds, grapes, &c. This, if true, was perhaps by a similar process to that now performed in Italy, for growing jasmines and other flexible plants, on an orange stock, by the mere cheat of boaring out the orange stem, through which the stems of the other plants are made to pass, and which soon grow so as to fill it closely, and to appear as if growing together, the roots intermingling. They are, of course, very short-lived.

The advantages of grafting are many and great. One of the most striking and gratifying changes that can be effected by it may be made upon a common quick hedge; and the more it has been neglected the more striking the change. Let the hedge be cut down to its proper height, leaving the best of the tall ones to form standards, about a rod apart. Let these be grafted with the best varieties of thorn,—the single and double scarlet, single and double white, the large fruit-bearing, and all the most distinct of the family. This neglected hedge may be thus made a very beautiful feature, and in two seasons produce a collection of handsome thorns, equal to seven-year old trees, simply because they are grafted, at the height they are wanted, upon strong, well-established stocks, making the hedge an ornamental boundary. It is needless, perhaps, to say, that the hedge itself must be kept well trimmed, and the growth of the common portion of the grafted stocks, which is in sight and forms the trunk, must be always taken off as it appears. This is one of the advantages of grafting.—Another is, that those who find they have many trees with secondary kinds of fruit, may in two years make a total change. Those who have a Windsor pear-tree, which, as compared with others, is not worth the ground it stands on, may change them to the Bon Chretien, Gansells, Burgundy, the Pas Colmar, or Maria Louise, by the simple operation of grafting; and if they do not like to lose all the old until they have some of the new, they may graft some of the strongest and best of the branches with their good fruit, and only cut away the old as the new advances. A vigorous vine of the common sorts of grapes may be grafted with the best. Plum-trees may be turned from one kind to another. The most common apples may be made in a short time to give place to the best, and perpetual changes may be wrought without disturbing the supply or the appearance of the old, though it is far better to take the head clean away from a tree all but the branches to be grafted, and thus throw the whole vigour of the plant into the new wood.

But still more effective are changes in shrubberies, which can be made with great facility by grafting. The common laurel, the common rhododendron, the common arbutus, and every other common tree or shrub, can be made to bear the best varieties of their several families. The rhododendrons and the azaleas may be grafted with all the best hybrids that are sufficiently hardy. The common arbutus may be grafted with Arbutus procera, A. andrachne, and others. In short, not only may the common shrubs, which abound on all old establishments, be made to bear the best, but even the timber trees may, in many cases, be made subservient to similar purposes, with regard to other species. Oak, beech, laburnum, willow, holly, and others, may be the means of introducing whole collections by the mere operation of grafting. Turn from the grounds to the houses, and there we find, perhaps, large common Camellias; grafting judiciously will hasten the possession of a fine collection of extraordinary size. Corræas, Azalea indica, Acacias, and many other plants, of which there are strong old specimens, in vigorous health, may be soon changed in variety; and although for real beauty many young plants would be preferable, yet a gardener can often obtain a graft which he could set growing at once, and soon have ten times the wood that he could procure by means of the healthiest cuttings and most rapid growth. In conservatories, many plants are fixtures; and here it may be very desirable to change a portion of the specimens to other varieties; and, independently of all this, there are some healthy subjects, which might be made to carry half a dozen different varieties on the same well-established stock. It is so with camellias, acacias, azaleas and other hard-wooded plants.

Again, there is a great advantage to be derived from grafting many plants, even to propagate them; because a variety, which may be delicate, can be grown better on a vigorous stock. When Mr. Smith, of Islington, made a little fortune of *Corræa speciosa*, he propagated on Corræa alba, a much more vigorous growing variety; and by this means got it rapidly into stock, while others were striking it, and coaxing their plants on at a snail's pace. Another advantage Mr. Smith got by this mode: the smallest piece of wood with an eye to it would make a plant, and the stuff required for a cutting would make, in some cases, a dozen. This applies to many plants, and even to roses. The vigorous growth of the common brier agrees well with many roses whose growth would be slow on their own roots.

In short, the great advantage obtained by grafting is that of being able to appropriate the entire vigour of an old established plant to the single piece of wood which we attach to it by grafting; and whether this be in the ground or in pots, or whatever be the nature of the subject, there is no other means by which the object can be effected, unless it be by budding, which, after all is said and done, is but a branch of the same operation; the difference being, that whereas by grafting we attach a piece of the wood, with, perhaps, several eyes, by budding we cut out each eye with a small piece of the bark, and by cutting a slit in the bark of the stock, and raising it on each side, we are enabled to tuck in the small piece with the eye to it, and bind it there. In this case the operation of tucking the one bark under the other is facilitated by making a cross cut. It is obvious that every eye on a new variety can be thus made into a plant, and the whole vigour of the stock, as in the case of grafting the other way, is thrown into the growth of the new variety. This practice is more adopted in some subjects than others. Roses are nearly all propagated by budding; and those who wish to form a collection cannot do better than provide themselves with briers, and bud them at Midsummer, or thereabouts, with all the varieties they require. See the article BUDDING.

GRAIN. The name of a small weight, the 20th part of a scruple in apothecaries' weight, and the 24th of a pennyweight troy.

GRAIN. This term includes all those kinds of grass which bear a straw, and which are cultivated on account of their seeds for the production of meal or flour. The word *corn*, or its equivalent in other languages, is frequently applied exclusively to that kind of grain which constitutes the chief nourishment of the country. Thus, in a great part of Germany, it is rye; in France, it is wheat; in the Low Countries, spelt; and in North America, maize. That the different kinds of grain grow wild in some countries, is well known, as, for example, barley and oats in Germany; but they have not the perfection of the cultivated grains. These all seem to be natives of warmer climates in Asia, Africa, America (South), and to be annual plants, becoming hybernating only from cultivation, since a summer does not suffice, in northern climates, for their development. In common with most grasses, they form their stalks or stems upon the lower joints of the root. Their fascicular roots spread themselves out chiefly upon the surface of the ground, which they almost cover with their thick web, while a smaller part penetrates deeper, when they find looseness of soil and nourishment to attract them. All kinds of grain contain nutritious particles of a similar character, although they vary, both in their quantity and in their mixture, in various grains. These elements are,—1. gluten which affords the strongest nourishment for the animal body; 2. fecula or starch which is very nutritious, although not so much so as gluten, which, however, it seems to render more digestible; 3. a sweet mucilage, which is more nutritious than starch, but is small in quantity, and renders the grain liable to the vinous and acetous fermentation; 4. the hulls, which consist of a fibrous matter, and contain a digestible aromatic substance; 5. moisture, which is predominant even in the dryest grain, and increases the weight of the mass, although it lessens the specific gravity; it affords no nourishment, hastens the decomposition of all kinds of grain, if they are not kept very dry, and serves, after planting, to stimulate the first motions of the germ.

GRAIN DRILL MACHINE. See SOWING-MACHINES.

GRAIN OF PARADISE,—botanically *Amomum Grana Paradisi*. A tropical, perennial-rooted, herbaceous plant, of the ginger tribe. It has a height of about a foot, and bears a red flower in February and March, and is cultivated in Madagascar for the sake of its seeds. But the grains of paradise used in pharmacy are the produce of several species of scitamineous plants, and are imported to Britain from both the shores of the Indian Ocean and the western coast of Africa. They are warm and stimulating, and are often administered, as a cordial, to diseased cattle; but they act with so much power as to be highly dangerous under any tendency to inflammation, and as to be proper only in such cases of extreme debility of the whole system, or of almost total inaction of the stomach, as require a decided stimulant. They were formerly a principal ingredient in tinctures for the cure of human toothache.

GRAIN-RENT. See RENT.

GRAINSICK, or MAWBOUND. A great and dangerous distension of the rumen of cattle, either with food alone or with food and gas. It differs from hoove essentially in the distension being more solid than gaseous, and symptomatically by the absence of eructation, and by the hardness of the flanks and the smaller volume of the swelling. It arises from gorging with almost any kind of food, even with grain or with chaff, at a sudden change of diet; but is particularly liable to arise from a surfeit of turnips, fresh grass, or any other succulent food, at the commencement of the season. The probang ought to be introduced, either to decide whether the case be one of hoove or one of grainsick, or to ascertain the degree in which the latter disease exists. If the probang bring off a sudden rush of gas, the disease is wholly or chiefly hoove; and if it encounter a solid resistance the disease is grainsick, and exists in a degree of aggravation proportioned to the nearness of the point at which the resistance is felt.

In mild cases of grainsick, when the animal does not seem to suffer much pain and is not materially fevered, but merely ceases rumination, refuses to eat, and lies long and indolently in one posture, a dose of castor oil and a little forced walking in the yard or the field, are frequently sufficient to effect a cure. In cases which, though on the whole mild, are accompanied with a kind of inertia, or with an insuperable reluctance to rise or to move about, aromatics and even stimulants, such as the usual cordials or ammonia, or ether or diluted alcohol, may be required to rouse the rumen into renewed action; but whenever such remedies are necessary, they must be given in cautious doses, and always accompanied with some gentle purgatives. In very bad cases, when the animal seems sinking through inertness into death, or in which it moans, swells at the sides, becomes almost as hard as a board in the flanks, appears to suffer great and increasing pain, and seems eventually to be overwhelmed with anguish and to be passing into unconsciousness, the practitioner must promptly decide whether he has sufficient time and encouragement to try the effect of stimulants, purgatives, the stomach-pump, and other comparatively gentle measures; and if not, he must cut through the left flank into the rumen, and mechanically withdraw the contents. The cutting operation itself is attended or followed with little danger; but in the extracting of the food, no matter how carefully performed, some small portion is liable to drop into the abdomen; and this, in consequence of its indigested condition, resists absorption or expulsion, undergoes an irritating decomposition, and may very probably originate some serious inflammatory disorder. Any animal which has suffered a very bad case of grainsick, ought, immediately after complete restoration to health, to be sent to the shambles; for, independently of the lurking danger consequent on the artificial extraction of the food, or even upon the relaxation which follows the administration of a stimulant, the rumen is so much overstretched and injured by the mechanical effects of the distension as to be temporarily incapacitated for the proper discharge of its functions.

GRAIN-WEEVIL. See CALANDRA.

GRAIP. See FORK.

GRAMINEÆ, or GRAMINEOUS PLANTS. See GRASSES.

GRAMMATOPHORA. See GEOMETERS.

GRAMMATOPHYLLUM. A genus of splendid, tropical, epiphytous plants, of the orchis tribe. The showy species, *G. speciosum*, was introduced to Britain from India in 1837; and has been called by some botanists *Epidendrum scriptum*, by others *Cymbidium scriptum*, and by others *Angræcum scriptum*. It attains a height of 6 or 7 feet; and is, in many respects, a magnificent plant.—The many-flowered species, *G. multiflorum*, was introduced in the same year from Manilla; and created great excitement and expectation among florists and botanists, partly from the remarkable size of its pseudo-bulbs, and partly from the apparent luxuriance of its habits, but chiefly from its supposed identity with the celebrated letter-plant of Amboyna, Java, and the neighbouring coasts,—so called on account of its flowers being marked with deep brown stains in such an arrangement as to resemble grotesque alphabetical characters. The many-flowered grammatophyllum proved to be not the letter-plant, and decidedly inferior to it; and yet, in spite of disappointing ardent expectation, it is generally admitted to be a gorgeous object. Its pseudo-bulbs are very large and nearly round; its racemes are drooping, very large, and many-flowered—and one of the earliest racemes produced in Britain was upwards of two feet long, and bore 48 flowers, each about an inch and a half in diameter; the sepals are flat, oblong, and very blunt; the petals are acute, and sometimes rather narrower than the sepals; the labellum is three-lobed and downy or hairy; and the whole plant has very much the appearance of a gigantic cymbidium, with long coriaceous leaves. The flowers want richness of colour; but are both profuse in number and very large in size. "I have before me," says a writer in the Botanical Register, "a single flower from Dr. Wallich's Herbarium, gathered at Pulo Dinding in Cochin China, which must have been 4 inches from the tip of one sepal to that of the opposite petal, or a foot in circumference."

GRANADILLA. The edible fruit of several species of the passion-flower. It is well-known as an open-ground production in the West Indies, and possesses some celebrity as a rare stove fruit of Britain; and is highly relished as a luxury for the dessert, by almost all who have tried it. It is, in every case, a sort of gourd-like apple, filled with numerous seeds and with a copious, subacid, and most delicious pulp; but it varies in size, in external appearance, and in relishable properties, according to the particular species which produces it. The granadilla of the *Passiflora edulis*, a species now very common in the hothouses of Britain, grows abundantly and ripens well, in any ordinary greenhouse, and without any extraordinary culture; and it is larger than a damson plum, and has yellow pulp, dark-coloured seeds, and a peculiar but very agreeable flavour. The fruit of some other species, however—particularly of *P. quadrangularis*, *P. laurifolia*, and *P. maliformis*—is greatly superior, but can very seldom be produced in hothouses without some special treatment of the flower. Plants in the open ground of the tropics undergo a rapid reduction or withering of the fleshy filamentous rays of the flower, and are, in consequence, quite free to develop their fructification; but plants in hothouses want the ventilation requisite to the early withering of the rays, and suffer a stagnation in the little cavity of their flowers from artificial waterings, and therefore require to have the rays cut early out with a small pair of very sharp scissors, and also, in some cases, to have their stigmas artificially touched with a little pollen by means of a feather or any other bit of soft substance, in order to their even developing their fruit, and especially to their bringing it to maturity. But the process, when once understood to be necessary, is easily performed.

GRANARY. An apartment, a division of a building, an entire building, or a very extensive store, for containing and preserving grain. A portion of the barn or a single apartment is sufficient on a small farm; a division of a building or an entire building is requisite on a large farm; and a very extensive store, or a series of large buildings, is necessary in a seaport town which forms a focus of the corn-trade or a place of great and frequent shipments of grain. Every granary, whatever its capacity, ought to be dry, well-ventilated, inaccessible to vermin, and conveniently situated for both receiving and surrendering its contents; it ought to have appliances for regulating ventilation according to the condition of the corn and the state of the weather; it ought to afford scope for the special treatment of any grain which may happen to be attacked by disease; it ought to be so situated and constructed as to be free from injurious temperature, and from any access of foul air or damp vapour; and if it be more than a mere room or recess, for keeping a small stock of corn for a single month or two in sacks, it ought to be divided into sections by means of either fixed or moveable deal partitions, in order that, without waste of space, different kinds of grain, and different parcels of the same kind, may be effectually kept separate.

"The most convenient situation for a granary," says Sir John Sinclair, in reference to farms, "is either over the threshing-floor, or adjoining to the end of it. The most common situation, however, is above the cart sheds, which are usually at some distance from the barn. In this case, the corn must be carried from the barn in bags, and raised to the granary by means of a small crane, or by a stair erected for the purpose. When the granary is contiguous to the barn, the labour is somewhat abridged, though a crane or a stair be still necessary. But when it is placed above the threshing-floor, the corn is at once raised either by the threshing machine itself, or by means of a crane or windlass from the ground floor, through a hatchway, and deposited in the granary without exposure to the weather, and with the greatest expedition and the smallest labour. The barn door is so wide as to allow a cart to enter it backwards upon a piece of pavement; so that when the corn is to be sent to market, it is dropped into the cart through the hatchway, instead of being carried on men's backs, which is still too often the practice even when a crane could be used with advantage.—It is often necessary to carry corn to the granary when but very imperfectly dried; and when it is kept for some time, it contracts a disagreeable smell, however dry it may be at first. It is therefore of great advantage to place the granary in an exposed situation, to give free access to air by means of sash windows, or boards overlapping each other, that may be raised or shut at pleasure. The granary, when placed above the threshing-floor, is so high as to give free access to the air from all quarters without the interruption of the other buildings, or even of the stack-yard.—For the more effectual exclusion of vermin, granaries have been constructed over detached cart-sheds, the sidewalls of which are discontinued about two feet from the top. The granary is supported by smooth round pillars with stone copes projecting one foot round the top of each. Vermin are more effectually excluded from a granary placed within the barn above the threshing-floor, both by its height and the difficulty of access, and by the frequent operations on the lower floors. Wherever the granary is placed, the sidewalls must be raised a few feet above the floor; and an additional floor is indispensable in every case. There is therefore no greater expense incurred by placing it on a third floor under the roof of the barn, than in any other part of the buildings." See the article FARM-BUILDINGS.

The granaries in Lithuania and the Ukraine and some other equally unmodernized parts of Europe are subterranean, in the form of cones or sugar-loaves or vast wells, wide below and narrow above, the sides well plastered, and the top covered with stones; and the grain, before being put into them, is thoroughly dried, if not by means of natural heat and drought, at least by means of ovens. The granaries of Egypt and some other parts of Africa are very similar to these, but far more close and durable, and somewhat differently treated. They consist of excavations, in the form of deep pits, in the solid rock, just wide enough at the top to allow a man to enter, and afterwards expanding to a width of 30 or 40 feet, and usually square or four-cornered; and they are commonly employed as stores and even as hiding places of the cereal wealth of the principal inhabitants, whether merchants, chiefs, or princes. A layer of straw is spread upon the floor; alternate layers of grain and straw are deposited up to the top; a hurdle of green boughs or a layer of brushwood is placed upon the mouth; a layer of sand, two feet thick, is deposited upon the hurdle, up to about the level of the surrounding ground; and a little mound of earth is deposited over the whole, and well trodden together, in order to throw off all rain and other surface water, and prevent any from finding access to the grain. The corn thus stored is previously well dried by two or three days' exposure to the play of the sun's rays; it always keeps, in the granaries, three, four, or more years in a perfectly sound condition; and if—as frequently happens—it should be forgotten in consequence of some disaster happening to its owner, and should, after the lapse of many years, be accidentally discovered, it will very probably be found in quite a good enough state to be freely used for food. But such a quantity of carbonic acid is accumulated in even those which remain shut for no more than two or three years, as to be exceedingly dangerous to any person who incautiously and suddenly removes the covering, so as to open communication with the atmosphere. Yet, except for this disadvantage, which can easily be guarded against by a little caution, the subterranean air-tight granaries appear to be far preferable to any other kind for preserving grain, during a series of years, in a sound condition. Some granaries or corn-magazines at Grand Cairo are defended with good walls and called Joseph's granaries; and though probably of far lower antiquity than the time of the patriarch, they seem to be ancient, and have been the repositories of enormous quantities of grain.

"The ordering of the corn in many parts of England," said the Society of Gentlemen's Complete Farmer in 1766, "is thus: After cleaning the corn, they screen it; and then, bringing it into the granaries, it is spread about half a foot thick, and turned from time to time about twice in a week; once a-week they also repeat the screening it. This sort of management they continue about two months, and after that they lay it a foot thick for two months more, and in this time they turn it once a-week, or twice if the season be damp, and now and then screen it again. After about five or six months, they raise it to five or six feet thickness in the heap, and then they turn it once or twice in a month, and screen it now and then. When it has lain two years, or more, they turn it once in two months, and screen it once a-quarter; and, how long soever it is kept, the oftener the turning and screening is repeated, the better the grain will be found to keep. It is proper to leave an area of a yard wide on every side the heap of corn, and other empty spaces, into which they turn and toss the corn, as often as they find occasion. In Kent they make two square holes at each end of the floor, and one round in the middle, by means of which they throw the corn out of the upper into the lower rooms, and so up again, to turn and air it the better. Their screens are made with two partitions, to separate the dust from the corn which falls into a bag; and when sufficiently full, this is thrown away, the pure and good corn remaining behind. Corn has, by these means, been kept in our granaries thirty years; and it is observed, that the longer it is kept, the more flour it yields in proportion to the corn, and the purer and whiter the bread is, the superfluous humidity only evaporating in the keeping. At Zurich, in Switzerland, they keep corn eighty years or longer by the same sorts of methods." Some of the most extensive and convenient seaport granaries in the world are at Dantzic. These are seven, eight, or nine stories high, and have funnels in the midst of the floors to let the corn down from the upper stories to the lower; they stand within the margin of the sea, at such a depth as to allow vessels to come up to their walls for lading; and they, at the same time, are so well constructed as to be perfectly free from damp.

GRANATUM. See POMEGRANATE.

GRANGE. A repository of corn, whether barn or granary, attached to a house or a farmstead; also, a parochial territory which formerly belonged to a monastic establishment, and is now tithe-free, and has not, within its own limits, any ecclesiastical provision in connexion with the Established Church.

GRANGEA. A genus of exotic, yellow-flowered, annual plants, of the chamomile division of the composite order. A number of species have been introduced to Britain from China, India, Egypt, and Australia; but only two of these, *G. cinerea* and *G. decumbens*, possess any interest for the florist.

GRANIFEROUS PLANTS. The grain-bearing grasses, and all other plants, whether leguminous or otherwise, which produce seeds of similar appearance and properties to grain.

GRANITE. A species of rock, considered as the foundation-rock of the globe, or that upon which all secondary rocks repose. From its great relative depth, it is not often met with, except in Alpine situations, where it presents the appearance of having broken through the more superficial strata of the earth, the beds of other rocks in the vicinity rising towards it at increasing angles of elevation as they approach it. It is generally composed of quartz, felspar and mica, more or less perfectly crystallized and closely united together. They vary considerably in the relative proportions in which they exist, in the granites of different localities, as also in the size of the grains; but felspar is usually the predominating ingredient.

Granite has been divided into several subspecies, or varieties; of these, the following are the most important: *Common granite*, in which the three ordinary constituents above-mentioned occur in nearly equal proportions; the felspar may be white, red or grey. *Porphyritic granite*, in which large crystals of felspar are disseminated through a common granite, whose ingredients are fine-grained. *Graphic granite*, which consists of felspar in broad laminæ, penetrated perpendicularly with long, imperfect crystals of quartz, whose transverse angular sections bear some resemblance to certain letters, especially to those of Oriental languages *Sienite* or *sienitic granite*, in which hornblende, either wholly or in part, supplies the place of mica. *Talcy* or *chloritic granite*—the *protogine* of the French—in which talc or chlorite takes the place of the mica. *Felspathic granite*—the *white-stone* of Werner, and the *eurite* of the French—in which felspar is the principal ingredient. Granite occurs in masses of vast thickness, which are commonly divided, by fissures, into blocks that approach to rhomboidal or tolerably regular polyhedral forms. In some instances, however, it affects a laminated structure, owing to the preponderance of mica, and its arrangement in layers. When this is the case, it passes into the rock called *gneiss*.

The aspect of granitic mountains is extremely diverse, depending, in part, upon the nature of its stratification, and the degree of disintegration it has undergone. Where the beds are nearly horizontal, or where the granite, from the preponderance of felspar, is soft and disintegrating, the summits are rounded and heavy. Where hard and soft granite are intermixed, in the same mountain, the softer granite is disintegrated, and falls away, leaving the harder blocks and masses piled in confusion on each other, like an immense mass of ruins. Where it is hard, and the beds are nearly vertical, it forms lofty pyramidal peaks or *aiguilles*, like the Aiguille de Duc and others, in the neighbourhood of Mont Blanc. Granite forms some of the most lofty of the mountain chains of the eastern continent. In Europe, the central part of the principal mountain ranges is of this rock, as in Scandinavia, the Alps, the Pyrenees, and the Carpathian mountains. In Asia, granite forms a considerable part of the Uralian and Altaic ranges of mountains; and it appears, also, to compose the principal mountains that have been examined in Africa; whereas, in the western hemisphere, it has never been observed rising to such great elevations, or composing such extensive chains. It is, nevertheless, very abundantly distributed over the northern parts of the American continent, as in Labrador, the Canadas, and the New England states. In New Hampshire, it is the predominating rock of the White mountains, in which it attains the elevation of more than 6,000 feet. In the Andes, it has been observed at the height of 11,000, but is here generally covered by an immense mass of matter, ejected by ancient and recent eruptions.

Granite very frequently forms veins, shooting up into the superincumbent rocks, which seems to indicate that it has existed below in a state of fusion, the heat of which has softened and parted the upper rocks, and forced up the granite, in a melted state, into these fissures. Granite abounds in crystallized earthy minerals; and these occur, for the most part, in those masses of it existing in veins. Of these minerals, beryl, garnet, and tourmaline are the most abundant. It is not rich in metallic ores, though it contains the principal mines of tin, as well as small quantities of copper, iron, tungsten, bismuth, silver, columbium and molybdenum.

Granite supplies durable materials for architecture, and for decoration. It varies much in hardness as well as in colour; accordingly there is room for much care and taste in its selection.

GRANIVOROUS ANIMALS. Animals which wholly or partially feed on grain or on other seeds.

GRAPE. See Grape-Vine.

GRAPE-HOUSE. See Vinery.

GRAPE-HYACINTH,—botanically *Muscari*. A genus of small, hardy, bulbous-rooted, ornamental plants, of the asphodel tribe.

The common or botrys-like species, *Muscari botryoides*, grows wild in the vineyards and cornfields of France, Italy, and Germany, and was introduced to Britain toward the close of the 17th century, and has long been a very common ornament of the flower-borders of almost all kinds of gardens. It needs no care in cultivation; and, when once planted in a garden, it greatly multiplies itself, and takes such pertinacious possession of the soil that it cannot easily be rooted out. Its bulbs are small and round; its leaves are numerous, narrow, about 6 inches long, incurved on the edge, and shaped like a mimic duct; its flower-stem rises from amongst the leaves, and is naked and about 6 inches high; and its flowers grow in a close spike upon the upper part of the stem, and sit very close to it, and are shaped like mimic pitchers, and have a smell similar to that of fresh starch or of the stones of fresh plums, and bloom in April and May. The flowers of one variety of this species are blue; those of another are white; and those of a third are ash-coloured.

The musk species, *Muscari moschatum*, called by Linnæus *Hyacinthus Muscari*, is a native of the Levant, and was introduced to Britain about the same time as the common species. Its bulbs are oval and comparatively large; its leaves rise from the crown of the bulbs, embrace one another at the base, and are 8 or 9 inches long, about half an inch broad, somewhat incurved on the sides, and blunted or obtuse-shaped at the points; its flower-stalks rise from among the leaves, and are naked below and about 8 or 9 inches high; and its flowers grow in close spikes on the upper part of the stalks, and have oval pitcher-shaped petals, reflexed at their brim, and are of an ash-coloured purple, seeming as if faded, and emit an agreeable fragrance similar to that of musk, and bloom in April and May. This species makes but a poor show with its flowers; but when planted in sufficient quantity, it diffuses its musk-like fragrance throughout a considerable space. The perfume of this plant is alluded to in the name muscari; and the roundish blue flowers of the common species, grouped or spiked together in an arrangement similar to that of a bunch of grapes, are alluded to in the name grape-hyacinth.

The long-fruited species, *Muscari macrocarpum*, was brought from the Levant before the close of the 16th century; and has a flower-stem of only about 3 inches in height, and greenish-yellow flowers; and is regarded by some botanists as only a variety of the musk species, under the name of *M. m. flavum*.—The tufted or hairy species, *M. comosum*, was introduced from the South of Europe about the same time as the common species; and is blue-flowered and about 6 inches high, and comprises two varieties.—Four pretty species have been introduced since the commencement of the present century,—the pale-plue, the dark-purple, the peduncled, and the small-flowered; and several other species are known.

GRAPE-PEAR,—botanically *Amelanchier botryapium*. A hardy, deciduous, ornamental shrub, of the rose tribe. It was introduced to Britain about a century ago from North America; and it attains a height of 12 or 14 feet, and carries white flowers in April and May.

GRAPE-VINE. The vine, or grape tree,—*Vitis vinifera*, L.; *Vites*, Juss.,—it is perhaps superfluous to mention, has a twisted irregular stem, with very long flexible branches supporting themselves by means of tendrils; the leaves are large, lobed, alternate, on long foot-stalks; the flowers in a raceme, of a herbaceous colour, insignificant in appearance, but fragrant. The berry, or grape, is generally globular; in some varieties oval; of various colours, green, yellowish or amber, reddish-brown and black.

It has generally been said that the vine was introduced into this country by the Romans; but from Tacitus we learn that it was unknown in Britain when Julius Agricola had the command. It was probably first cultivated here in the time of the later emperors,—perhaps about the close of the 3d century. At the date of the Conquest there seem to have been vineyards in the south and south-west of England. From that period downward to the Reformation, vineyards appear to have been attached to all the principal religious foundations in England; and it is somewhat curious that from the time of the Reformation to the present day they have in a great measure disappeared. A few, however, have occasionally been formed. From the 'Museum Rusticum' we learn, that one was established at Arundel castle in Sussex about the middle of the last century; and that in 1763, there were in the Duke of Norfolk's cellars sixty pipes of English burgundy, its produce. Professor Martyn of Cambridge has drawn together the evidence concerning the culture of the grape-vine in Britain in former times, and the practicability of resuming it; and he concludes, that in former times there were many real vineyards in England,—not merely orchards and plantations of currants, as the Hon. Daines Barrington and others have suspected. He also gives it as his opinion that vineyards might still be successful in the southern and western parts of England, in proper soils and situations, if conducted by persons skilled in their management. The earliest and hardiest grapes, or those best suited to the climate, are not, however, well calculated for the making of wine. The Miller and small Black cluster may do; but they are inferior to the large Black cluster, which has an austere taste. Mr. Vispré, in 1786, published a dissertation on the growth of vines in England. He proposed to train the shoots, like the runners of melons and cucumbers, near the ground; and he actually found that the berries thus produced were larger than those of the same kinds trained against a south wall. In the north of France, it is well-known, the vines are trained very low, not rising more than four or five feet from the ground.

Varieties.—Parkinson, in 1629, describes twenty-three kinds of grape vines, several of which are still cultivated, and in high esteem, such as the Muscadines, and the Frontignacs. The following are the principal kinds at this time cultivated in Britain:

WHITE GRAPES.

The *White Muscadine* is very generally cultivated against open walls in the southern parts of England; and, being an early grape, ripens well. The berries are roundish, thin skinned, and of an amber colour when ripe; at which time their juice becomes sweet, and of delicate flavour. The bunches are small, but many are produced. Forsyth says, that it is the best vine we have for a common wall, and a great bearer; and Speechly remarks that it is often cut and eaten before it be fully ripe, but that, when well-matured, it is an exceedingly fine grape.

The *White Sweetwater* is likewise an excellent early grape, much cultivated in the open air. The berries are round, not of equal size, some being as large as cherries, while others remain nearly as small as mustard seeds; they are thin skinned, and full of juice, which is sugary but not vinous. When nearly ripe, they become of an amber colour; when clouded with russet, they are in perfection. Nicol remarks, that this grape, like the former, is often cut before it be fully ripe, and that this has occasioned it to be less in repute than it deserves. The shoots are thick and strong, but not long; the leaves very large.

The *White Frontignac* is a copious bearer. The berries are round, and of a good size, closely clustered on a long bunch somewhat shouldered. When ripe they are excellent; and remarkable for uniting the qualities of being fleshy, and having a sweet juice and perfumed flavour,—not so powerful, however, as that of the black and red varieties, the last of which has a very strong musky flavour. The ripe berries have a fine white bloom or farina on them, from whence the name is given. It has a place in the vinery, and and is also trained against open walls.

The *Malmsey Muscadine* grape has a sweet juice, and high flavour, and the vine is a good bearer. It is commonly planted in the vinery, but succeeds also against the open wall.

The *Royal Muscadine*, or White Chasselas, the D'Arboyse of Speechly and Forsyth, is an excellent grape for the vinery or the hothouse. The bunches are large and shouldered; the berries round, and amber-coloured when ripe; the juice rich and vinous.

This vine generally grows remarkably gross and strong, both in wood and foliage.

The *White Muscat of Alexandria*, or Alexandrian Frontignac, has large oval berries, which hang loose in the bunches, these being long, and not shouldered; when ripe the berries are amber-coloured, and the juice is then rich and racy; the skins are thick, and the pulp hard, but of a highly musky flavour. It is fit only for the grape-house or pine-stove.

The *White Constantia* berries are tolerably large, rather of an oval shape, of a sweet taste, with only a slight flavour. The bunch is of considerable size, and well formed. This is the kind which has acquired fame at the Cape of Good Hope: it is said to degenerate when transplanted. At Constantia it grows in a light sandy loam; the situation is low, but more elevated than other parts of the district. There is likewise a Red Constantia; and a Black Constantia appears in some catalogues; but this last has proved to be the same as the Black Frontignac.

The *White Hamburgh*, or Portugal grape, grows in large long bunches; the berries are oval, pale white, with a thick skin, and firm pulpy flesh. The vine is a plentiful bearer, and grows very strong both in wood and leaves. It much resembles the Syrian.

The *Tokay*, when well-managed, produces both large bunches and large berries, and becomes one of the finest grapes in the vinery. The berries are white, oval-shaped, skin thin, pulp delicate, and of agreeable flavour. The leaves on the under side are covered with a fine soft down like satin. It should be placed in the warmest end of the vinery, and is well suited for the pine-stove.

The *Greek grape* is a high-flavoured and delicate fruit. The berries are of moderate size, somewhat oval, bluish white: growing close, in middling sized bunches. The leaves of the tree resemble those of the sweetwater, but stand on shorter footstalks. It is a plentiful bearer either in the vinery or hothouse.

RED GRAPES.

The *Brick grape* gets its name from the berries being of a pale red or brick colour; they are thin skinned, with a sweet juice. The bunches are small, but two or three often proceed from the same shoot, so that the vine is upon the whole a plentiful bearer. It succeeds on walls and treillages, and is hardly deserving of a place in the vinery.

The *Red Frontignac* is an excellent musky flavoured grape, when fully ripe, of a brownish red colour. The juice of this, says Miller, has the most vinous flavour of all the sorts, and is greatly esteemed in France. It is well-calculated for the vinery.

What is called the *Grizzly Frontignac* seems to be only the red in an unripe state, at which time the berries are greyish-coloured, with a few dark stripes.

The *Red Hamburgh* or Gibraltar grape, grows in large bunches; the berries are somewhat oval shaped, of considerable size, thin skinned, red when ripe, juicy, with a rich vinous flavour. It is suited only for the vinery and hothouse.

BLACK GRAPES.

Of the black grapes, one of the most hardy kinds is called the *Miller* or *Dusty Miller*, from a white powdery appearance on the surface of its leaves: it is nearly allied to the black cluster grape. It is much cultivated in gardens, and against the front and gable walls of houses in the south-west of England: the fruit ripens freely, and is very good, the skin and pulp being delicate, and the juice sweet and pleasant; the berries are oval, of a middling size, and closely placed to each other in the bunches.

The *Early July* has small black round berries, with large stones; they grow loose on the bunches, which are small, but numerous; the juice is sugary, with but little flavour. It ripens early in September, without fire-heat. There is also a white July grape, which is little cultivated.

The *Black Sweetwater* is a small roundish grape, growing close in the bunches; the skin is thin, and the juice very sweet. It ripens early, and is calculated either for the vinery or the wall.

The *Small Black Cluster* resembles the Miller grape, but the leaves are not quite so hoary, and are rather smaller. The fruit is sweet, and of delicate taste. This is extremely common on walls of houses near London.

In the *Large Black Cluster* the berries are oval, and grow close in the bunch, which, notwithstanding the name, is not large. The juice has a harsh taste, and makes the palate feel rough, as in tasting port-wine; Mr. Speechly indeed considers it as the sort used in the manufacture of that celebrated wine.

In the *Black Muscadine* the bunches and berries are smaller than in the white; it is a very productive kind and makes a fine appearance, the black berries having a bluish bloom. Fit for the vinery or the hothouse.

The bunches of the *Black Frontignac* are long, and the berries, which are round and of moderate size, are thinly or loosely hung on them. They are of good quality, the juice being vinous, and of exquisite flavour.

The *Black Hamburgh* is well known and generally liked. The berries are somewhat of an oval shape, the skin thick and the pulp hard; but it is a well-flavoured fruit, and the tree bears plentifully. The bunches are large, and handsomely shouldered. It answers very well in the vinery; but in the open air it comes to maturity only in very warm situations and in favourable seasons.

The *Alicant*, or Black Spanish grape, forms very long shouldered bunches, the berries being also large and of an oval shape; at first they are red or flame-coloured; but when ripe, they become of a dark brown or black colour; the skin is thick, and the stones are large; the pulp is soft and juicy, and of agreeable flavour. It is often called the Lombardy grape, and sometimes the Rhenish. It is excellent for the hothouse or the vinery. In autumn the leaves are finely variegated with red, green, and yellow.

St. Peter's Grape has the berry large, roundish, and black; skin thin; the bunches large, handsomely formed, and making a fine appearance at table; the pulp delicate and juicy. The vine is a good bearer, but the grapes are late of ripening. They are apt to crack in the forcing-house, or in the vinery. In fine seasons, this kind ripens on a south wall.

The *Claret grape* is distinguished by its harsh sourish taste, and dark claret colour; when the grapes are perfectly ripened in a hothouse, however, the taste is pleasant. The berries are small, and grow close, on small bunches. The leaves are large, and acquire a russet red or claret colour; on which account they have been recommended for making vine-leaf wine.

The *Black Prince* is an excellent grape, well-deserving a place in the hothouse or the vinery, where it produces both large berries and large bunches. Even on the open wall, in the south of England, it succeeds in favourable seasons: Forsyth mentions, that in this way he has had bunches which weighed a pound and a half, and which ripened in October.

Besides the list already given, two or three others deserve notice.

The *Verdelho*, or Verdellio grape of Madeira, is the kind from which the celebrated Madeira wine is understood to be principally made. The vine grows with great vigour in our grape-houses, and is remarkably productive of fruit, frequently yielding three bunches on a shoot. Here, however, the bunches are but small; the berries are also of diminutive size, of an oval shape, green colour, and with a thin skin. The fruit is very acid till it arrive at the last stage of maturity, when the berries become of a fine amber colour, and of a very rich saccharine taste, with considerable flavour. The leaf is dark green, and very thick; and would resist the autumnal frosts, and protect the fruit till a late period in October. The Verdelho is much cultivated in the province of Languedoc in France. It is described by Delaunay under the name of Verdal, and is highly esteemed at Paris, its berries being accounted the most sugary and delicate in flavour of all the dessert sorts. In France the bunches become tolerably large, and very beautiful; and the berries also acquire considerable size.

The *Raisin de Carmes*, or, as it is sometimes called, *Raisin de Cabo*, is a grape of fine qualities. The fruit is produced in rather loose long bunches; the berries large and of an oval form. The skin is thickish, of a dusky purple colour, covered with a fine bloom; the pulp is firm and extremely rich, though containing a considerable portion of acid. The filaments and anthers frequently remain when the fruit is ripe. This vine needs a high temperature; in the stove it grows freely and bears well, but it requires particular attention at the time of flowering. The wood is rather slender, of a yellowish-brown colour; the leaves small, and pale green.

.The *Raisin grape* is of a brown or blackish colour; large, oval, fleshy and firm, but with a pleasant juice; forming handsome long bunches. It also is only suited to the hothouse.

The *Syrian grape* is among the coarsest of the grape kind; but the vine is a good bearer under glass, and produces bunches of extraordinary size. The berries are large, oval, white, with a thick skin and firm pulp; they continue in good condition till January. In this country, Mr. Speechly has produced a bunch which weighed 19½ lbs.; and he describes another which was four feet and a half in circumference, and near two feet in length. This last bunch was sent to the distance of twenty miles as a present. Four men were employed, two by turns, carrying the bunch suspended on a pole or staff resting on their shoulders. No doubt one man could have carried the bunch, if the weight alone be considered; but it was a great object to transmit it without bruise or injury. This may tend to illustrate a passage in the Sacred Writings, where the description of this mode of carrying a bunch of grapes has sometimes very unnecessarily excited a sneer.

In warmer countries than this, vines that are suffered to grow without pruning attain a large size, their stems assuming the appearance of trunks of trees. Vines that are regularly pruned or dressed, cannot be expected ever to arrive at such magnitude. Even in the ungenial climate of Britain, however, they sometimes have a surprising size and expansion. The Northallerton vine, about the year 1785, covered a space of 137 square yards, and the circumference of the trunk near the ground was almost four feet; it was then considerably more than a hundred years old. Lysons, in his account of the 'Environs of London,' describes a Black Hamburgh vine at Valentines in Essex, the branches of which extended 200 feet, the stem being 1 foot 13 inches in circumference. It sometimes yielded 4 cwt. of grapes in a season.

New varieties of grapes are of course only to be procured by sowing the seeds. When this is intended, the grapes should be left on the vine till almost in a state of decay, taking care, however, if they be exposed to the open air, to cover them from the attacks of birds. The stones, in this very mature state, become of a dark brown colour; they are to be separated from the pulp, and laid in a dry airy place till spring. Mr. Speechly, in his work first published in 1786, recommends the bringing together of flowering branches of two different kinds of grape, calculated to modify or improve each other. The Frontignac and other high-flavoured grapes, he observes, may add flavour to other kinds; the White Sweetwater may be coupled with the Red Frontignac, with the Black Hamburgh, or with the White Muscat of Alexandria. He augurs, that the best sorts of grapes hitherto known, will at some future day be esteemed only as secondary or inferior. Mr. Knight supports these views, and indeed has done much towards their accomplishment.

Modes of Propagation.—The raising of new vines is by no means a very tedious process. The fruit of the seedling may in general be tasted in the fourth year; while a florist waits patiently for five or six years before his seedling tulips show flower, and perhaps nurses his breeders as many years more before they *break* to his mind.

Vines are often propagated by layers, which, when rightly managed, form good enough plants. Strong healthy shoots from different sides of the stool are bent down, generally in February, and gently twisted or notched; this twisted part is introduced into a flower-pot, filled with fresh mould, and which is sunk an inch or two beneath the surface. In the course of the summer, plenty of roots are sent out at the doubling, and in autumn the offset is separated from the parent plant. In the nurseries near London this mode is much practised; and both parent-plant and layers may often be seen bearing fruit, so that the kind can be positively ascertained. Abercrombie describes the mode of forming layers in the open ground; but the advantage of having the plants in flower-pots is evident, as a ball of earth can thus be preserved to the roots. Indeed, the roots of the vine are so liable to be injured in transplanting, that flower-pots should always be employed.

Vines are likewise extensively propagated by cuttings. These are taken off at the usual time of pruning in autumn or winter, and are kept till the following spring, merely by sinking them nearly to the top in dry earth. It was formerly considered of great advantage to have an inch or two of old wood to each cutting; the cutting was from a foot to fifteen inches long, and a single cutting only could in this way be made from a shoot. The Rev. Mr. Michell, a philosophical as well as practical horticulturist, first introduced the use of short cuttings, about three inches and a half long, and all consisting of the new wood, properly ripened, and having only one bud or eye. Plants raised in this way he found to be furnished with more abundant roots, to come sooner into bearing, generally in the second year, and to prove more fruitful than long cuttings, with several eyes and a portion of the old wood attached. These cuttings are often planted in a nursery-bed in the spring; but they are much forwarded by placing them, in pots, into the bark-bed of a stove. Mr. Michell usually planted his cuttings in the naked bark, four or five inches asunder; being short and throwing out tufty roots, they are easily potted when thought necessary. Shoots of strong growth, it may be remarked, are not good for cuttings, having too much pith. Many gardeners are of opinion, that plants thus procured from cuttings become better rooted, and grow more freely than those from layers. There is still another and a very speedy mode of propagating the vine, especially the more tender varieties, which will be described when we come to speak of the Vinery.

Culture.—In forming a border for vines, a matter of primary consideration is that the roots shall not be able to penetrate to a wet subsoil. To guard against this, it is common to take out the earth, and lay lime-rubbish, firmly beat down, in the bottom. Any fresh and light, but rich soil, to the depth of a foot and a half, or two feet at most, answers perfectly well. In France and Italy the most experienced vignerons are very scrupulous about permitting any gross or strong manures, such as dungs, to approach the roots of their fine vines, for fear of altering or deteriorating the flavour of the grapes. Rotted turf or clippings of box trodden under foot in the highway, are the manures there preferred. They who apply dungs, are considered as more anxious about quantity than quality. In this country, however, we must partly compensate for the want of a bright sky and hot sun, by giving vigour to the plants by means of manures, even if we should make some sacrifice of flavour. Marshall repeatedly urges the necessity of this, and recommends the digging-in of sheep's droppings or the cleanings of a poultry-house every year. Nicol too is a strenuous advocate for applying the essence of dungs, by watering vine-borders with dunghill drainings, which he declares to be the "nectar of vegetable life."

In planting vines, it is customary to cut clean, at the end, the strong root from which the fibres proceed. A hole or trench is then made in the border, corresponding to the length of the main root; this trench is formed with a ridge in the middle; and on this ridge the woody part of the root is laid, the fibres sloping down on each side. If the main root be three inches under the surface of the border, it is deep enough.

Training.—Hitt long ago recommended the training of the principal stem of the vine in a serpentine form, leading from it, parallel horizontal shoots, at the distance of eighteen inches from each other: from these, bearing branches are produced, which are nailed in, in an upright position, by which means, in his opinion, they are less apt to put forth collateral shoots, which rob the fruit. Forsyth has since shown the advantage to be derived from training the bearing-shoots also in the serpentine manner. This, it must be confessed, renders the laying-in of the summer-wood more troublesome; but, with a little practice, and due attention, all confusion or difficulty of that kind might be surmounted. It is evident that a good deal more bearing wood can thus be laid close to a wall, paling, or trellis, than by the ordinary method. Nicol approves either of the horizontal or zigzag manner being adopted on low walls or trellises; but for the grape-house he prefers training directly up the roof. It is well-known that in vineyards in the wine-countries, the standard vines are seldom allowed to rise higher than three or four feet. It is found, that against our walls vines grow much stronger and afford larger grapes when not allowed to exceed four feet in height. They thus enjoy the reflected heat from the earth as well as from the wall. Vines are therefore frequently placed in the low intermediate spaces between peach and nectarine trees.

The watering of vines in the open border, in very dry weather, is sometimes necessary; but not oftener, perhaps, than once a week. After the fruit is set, the garden-engine is occasionally used, and water sprinkled over the whole plant, this being found to promote the swelling of the berries. During summer the vine may be said to be constantly in a state of pruning. This consists in the regulation of all the new shoots, selecting the bearers for next year, and displacing all lateral, straggling and superfluous shoots. In July, when the fruit is formed, the bearing-shoot itself is shortened, in order to give vigour to the bunches. The vine is seldom, by judicious gardeners, divested of any of its leaves, which seem in this plant almost indispensable to the health and swelling of the fruit.

The removal of a small ring of the outer and inner bark from the stem or principal branches has been found to hasten the production and maturity, and increase the size and flavour of grapes; and this practice is now followed to some extent in the south-west of England. The width of the ring of bark taken out may be from an eighth to a quarter of an inch; the former being sufficient if the plant be weak, the latter proper if it be luxuriant. Care must be taken not to injure the alburnum. The proper time for performing the operation is when flowering is nearly over, and when the berries begin to be formed. In the course of little more than a fortnight, granulations of new bark make their appearance on the upper side of the incision; these gradually increase, till nature has restored the covering of bark. The ring of newly deposited bark is rough, and becomes protuberant; so that a gibbosity remains at the place. The vine-shoot swells and becomes much larger above than below the incision. On vines thus treated, the berries are said to be earlier, to swell much faster, and to become larger and better flavoured, than on neighbouring vines left uncut. In England, the vine usually flowers in the open air towards the end of June or beginning of July. If the circle of bark be removed at either of these periods, the part will be covered with new bark before the ensuing winter, and no injury will be sustained by the vine. In forcing-houses, the circle should not be removed till after the vine has flowered, the precise time depending on its state of forwardness. In very old vines it is not recommended that the incision be made on the main trunk, but on the middle-sized branches; and it may either be made on all the principal branches, or only on every other branch.

In connexion with this practice may be mentioned another, not altogether new, but which was brought into particular notice, in a pamphlet published in 1815 by the Right Hon. Sir John Sinclair, Bart. This consists in entirely removing the parenchymatous outer bark from the stem and principal branches, but carefully preserving the inner concentric bark. The operation is performed in November, or the beginning of December. At that season it is easily done with the common garden-knife, and there is then little danger of injuring the liber. The removing of old and rugged bark from vines has long been practised, with the view of preventing the lodging of insects, particularly the red spider; but besides being insured of exemption from these, the decorticated vines are said to make stronger shoots, and the quantity, quality, and flavour of the grapes to be thereby improved.

Vines seldom produce bearing-shoots from wood that is more than one year old, unless the old wood be healthy and well-cut back. The great object therefore is, to have abundance of wood of this age in every part of the wall or trellis. The bearing-shoots for the following year are commonly left with four eyes each; the undermost does not bear, and consequently only three are expected to be productive; but each of these yields two or three bunches of grapes, which grow from the new shoots of the current year, the fruit-buds being always opposite to the wood-buds. Sometimes more eyes are left, and more fruit is naturally produced; but it is not only inferior in size but in flavour. The shoots are laid in about eighteen inches asunder on the wall, to give room to the side shoots. Miller, Forsyth, and Speechly, unite in recommending for the time of winter-pruning, the end of October, when the fruit is all gathered. Hitt proposes to delay it till the end of January, or beginning of February, affirming that vines cut in October make weaker shoots than those pruned after mid-winter. The shoots which were lately bearers are cut back to some good lateral shoot, and a few extended naked old branches are entirely removed, or cut back to some promising young shoots. In either case, the cut is made about an inch above the bud; and sloped backwards from it, so as to convey away the juice which may exude.

An intelligent and successful American cultivator of grapes, furnished Mr. Thomas with the following description of the mode adopted by him in pruning: "Retain, in the first place, simply one upright of young growth, which in the winter should be trimmed down to five or six buds. The next season, allow one branch to grow on each side, which at the winter trimming should be laid down in a horizontal direction. These arms will send upright shoots, which will bear the fruit. The next season, the arms as well as all the uprights should be cut off, except the upright nearest the body of the vine; and so continue pruning each successive year. The original upright, when the root shall be strong enough to bear it, may be allowed to grow longer so as to have another set of arms, perhaps about three feet above the others, always taking care to let the arms grow from the wood of the previous year. When the grapes have attained about the size of a pea, the ends of the branches bearing them may be nipped, that they may not interfere in growth with the arms above. It is also well to take off the grapes which form on the upright shoot next the body of the vine, in order thus to insure a thrifty shoot for an arm the next season. The laterals or branches starting from the bud over each leaf, should be carefully taken off excepting one or two eyes. If they are all taken off, the bud which produces the fruit-bearing branch of the next year is sometimes forced, and a second growth of grapes will sometimes form, but never ripen."

If the wounds made in the autumn or winter pruning have not fully healed over, vines are apt to bleed when vegetation commences. Various remedies have been proposed. Hitt recommends, that after wiping the part dry, it should be basted with soot or with unslacked lime. Nicol is for searing the bleeding point, and then smearing it over with hot wax. Mr. Knight, from his own experience, recommends a composition of four parts scraped cheese and one part calcined oyster-shells, or lime, to be pressed strongly into the pores of the wood; the sap almost immediately ceases to flow; and if this composition be properly applied, even a large branch may be taken off at any season without detriment from bleeding.

On the open wall or trellis, grapes are very subject to the attacks of wasps. Some of the finest bunches may be saved by surrounding them with bags of crape or gauze. It may be mentioned, that bunches which have arrived at maturity only in the end of October, may be gathered by cutting off the shoots on which they grow: if these be suspended in a cool apartment, the fruit will keep for a month in a tolerably good state.

Early in the 18th century a kind of flued walls were first used for the forwarding, or rather for the thorough ripening of grapes, at Belvoir-castle in Rutlandshire, where Hitt, the author of a 'Treatise on Fruit-trees,' was an apprentice. Mats were at the same time thrown over the vines at night, to save them from the chilling dews and hoar-frosts that occur in April and May. Since that time flued walls, with moveable glass frames, have been much used; the same vines being brought into bearing every second or third year, and, in the intermediate time, prevented from exhausting themselves, by the removal of the flower-stalks as they appear. Glazed houses for the culture of grapes have also been formed, under the name of Vineries,—to be described under that article. Speechly remarks, that good crops of grapes may be obtained from vines trained against walls not more than six feet high, by making use of melon-frame glasses, a temporary narrow roof being made to receive the glasses.

In a few places in England, vines are planted in the vineyard form, in ranges, about twelve feet asunder, the shoots being trained in a horizontal direction, to a series of stakes, three or four feet high, placed along the ranges.

Grafting.—We must not omit to mention, that one sort of vine may be grafted on another, in the ordinary way. The operation, however, must be performed with great care and exactness. In this way, if a wall have been planted with kinds injudiciously selected, they may, by grafting, be very speedily changed, preserving all the advantages of having strong well-rooted plants. In a small vinery or vine-frame, various kinds of grapes may thus be inserted on one stock. Speechly mentions a Syrian vine which in this way produced sixteen different sorts of grapes. The principal advantage of grafting, however, is looked for in the modifying and improving of the various kinds; the weak and tender being grafted on such as are robust and vigorous; for example, the Black Frontignac, placed on the Syrian, is said to produce well-shaped large bunches, with berries nearly the size of those of the Black Hamburgh. This Syrian vine is excellent for stocks; and by some horticulturists, seedling stocks of it, grafted with other kinds, are accounted preferable to cuttings or layers of those kinds themselves. Vine-grafts are gathered at the time of the winter-pruning, from bearing branches; and they are kept sunk in light earth till the proper grafting season, which is about three weeks before the stock break into bud. Those in a hothouse must of course be grafted several weeks before those out of doors. The finer sorts are generally grafted by approach.

GRAPHITE. See Plumbago.

GRASSES,—botanically *Gramineæ* or *Graminaceæ*. A vast and most important natural order of plants. It comprises probably one-sixth of the whole vegetable kingdom, contributes to the green parts of the world by far the greater portion of their verdure, and includes hundreds and even thousands of species which constitute the daily food of animals; and yet it exhibits one of the simplest structures which occur among the perfect forms of vegetation, and is one of the most thoroughly natural orders known in systematic botany, and combines such amazing specific variety with general simplicity as to be comparatively very easy of study and arrangement. The grasses display to the economist a stupendous instance of the adaptations of plants to the uses of man and the lower animals; they afford the young botanist the best illustration of the truth and beauty of the natural orders of plants; and they demonstrate, in ten thousand ways, by their organism, their chemical transmutations, their connexion with soil and light and air, and the mighty and multitudinous parts which they play between lifeless elements and living bodies, the providence, wisdom, and benignity of the Creator. They comprise all the plants which yield corn, most of those which constitute pasture, some of the best which yield sugar, and not a few which abound in useful secretions, grateful juices, and fragrant odours. Their thousands of species are distinguished from one another, not only by obvious botanical characters, but by their nutritive values, their economical adaptations, their periods of flowering, their habits of hardiness and duration, their methods and seasons of growth, and their love or dislike of particular soils and situations. Their flowers, though unheeded or thought obscure by superficial observers, are remarkable for the perfection of their parts, the elegance of their structure, and the blending of only one set of differential marks with an enormous variety of generic and specific characters; and either by the texture of their organs, the number of their stamens, or the relation of their sexes, or especially by the form, texture, appearance, number, position, and arrangement of their glumes, paleæ and scales, they afford means of a far readier and surer discrimination, than if they were among the most gorgeous and complicated glories of the flower-garden.

General Botanical Characters of the Grasses.—The botanical characters of most orders of plants are too minute, intricate, or obscure to be readily appealed to by any persons but thorough botanists, or to be of much use for the guidance of ordinary cultivators; but those of the grasses are remarkably distinct, easily observable in all cases with the aid of a glass, and of the most eminent service for enabling farmers to discriminate species which present a closely similar appearance but possess widely different properties and values; and they require, therefore, to be known by all cultivators who intelligently manage grass lands, or wisely prosecute the alternate husbandry. The root, whether annual, biennial, or perennial, is fibrous. The stem is usually called a culm; it is woody and perennial in a few species, but is herbaceous and of only one season's duration in the vast majority; it is everywhere solid in the sugar-cane, but is commonly solid only at the joints, and fistular or tubular throughout the intermediate spaces in the rest of the order; it is sometimes but a few inches high, as in knappia, and sometimes 80 or 100 feet, as in the bamboo, but generally from 2 to 6 feet, as in most of the pasture and the cereal species; it is compressed in a few species, but cylindrical in the vast majority; and it has in all instances a complete coating, and in a few instances interior secretions, of a silicious substance strictly similar to glass, and sometimes as hard and impenetrable as a film of flint. A sheath, of the nature of a leaf-stalk, embraces the culm at each joint, and is slit on one side; and a leaf stands on each sheath, or grows from it, and is usually narrow and linear or ligulate, and has a membranaceous limb. The groups of flowers, in a few cases, are bundled together, and enveloped in a general spathe; in some cases, are closely packed upon an elongated and comparatively thick rachis; and in most cases, are arranged in spikes, in panicles, or in racemes. The florets, in a very few cases, are diœcious,—in a few, are monœcious,—and in the vast majority of cases, are hermaphrodite or polygamous; they have neither calyx nor corolla, but are supported by two sets of bracts, the outer ones called glumes and corresponding to the calyxes of other plants, and the inner ones called paleæ and corresponding to the corollas of other plants; and they vary in number upon each spikelet from two or even one to several scores or almost a multitude. The glumes occur only at the base of the group or spikelet, and may belong either to one floret or to many florets; the upper one, or even both, are sometimes a-wanting; the two are alternate; and the lower one is usually larger and more ribbed than the other, and frequently has its midrib prolonged into an awn. The paleæ are usually alternate and in pairs; the upper one is commonly two-veined, awnless, and smaller and more membranous than the other, but is sometimes a-wanting; and the lower one is usually keeled, may be either awnless or awned, and may have any number of veins from one to several or many. Two scales frequently occur on the sides of the base of the upper palea, and a third sometimes occurs in front of that palea; and these are regarded, by the majority of botanists, as the rudiments of a corolla. The stamens in most instances amount to three, in some instances amount to six, in a few instances have some other amount, and very rarely are indefinite; they have a hypogenous insertion, and stand all round the ovary when they amount to three or to six, but next the lower palea when they amount to fewer than three; and their filaments are long and flaccid, and their anthers bifid, linear, and versatile. The ovary is simple and solitary; it has generally two styles, and in a very few instances three; and each style has a branched or feathered stigma. The pericarp of the fruit is membranaceous and thin; and in some cases, it clings closely to the seeds, and in other cases is loose or distinct. The seed contains a comparatively large quantity of farina or starchy albumen; its cotyledon is thin and lenticular, and lies on the side next the lower palea, and turns its edge outward; its plumule and radicle are overlapped by the edges of the cotyledon, and lie against the side of the pericarp next the outer palea; the plumule consists of several mutually overlying sheaths, and is free; and the radicle consists of several tubercles, and commences its protrusion at a very early stage of germination.

Classification of the grasses.—The older botanists treated the grasses synthetically, and comprehended them in a very small number of genera; and the more recent botanists treat them analytically, and distribute them into a very great number of genera. Some of the principal modern classifiers are Endlicher, Kunth, Link, Palisot, Raspail, Trinius, and Dumortier; and the first, second, and third of these are commonly regarded as the best.

Endlicher distributes all the grasses into 234 genera; and collects these into 13 tribes, with the genera oryza, phalaris, panicum, stipa, agrostis, arundo, pappophorum, chloris, avena, festuca, hordeum, rottboellia, and andropogon for their types. Kunth brought together only about 2,500 species,—a number vastly below the real amount; and he grouped them into tribes, on a similar principle to that of Endlicher, with a conspicuous genus for the type of each tribe. Loudon, in his Encyclopædia of Plants, adopted Kunth's classification, and found it to embrace 108 genera of the indigenous and exotic species within Britain; and he exhibits 13 genera as of the panicum tribe, 2 of the stipa tribe, 20 of the agrostis tribe, 31 of the bromus tribe, 7 of the chloris tribe, 12 of the hordeum tribe, 3 of the saccharum tribe, 3 of the oryza tribe, 14 of the olyra tribe, 4 of the bambusa tribe, and 1 of anomalous character or uncertain place. Link classifies much more systematically; divides according to simple botanical characters, and subdivides according to the principle of typal groups; and produces a much more elaborate view of the grasses, and at the same time far more satisfactory one, than is afforded by other arrangements. Loudon, in his Hortus Britannicus, follows Link's classification, and shows it to have comprised within Britain, in 1830, 119 hothouse species, 59 greenhouse species, and 893 hardy herbaceous species, or, in all, 158 genera; and he gives a tabular view of it in reference to these genera, which may be advantageously consulted, and which we shall here briefly indicate. The first order consists of genera with terminal spikes; and comprises 5 genera of the ophiurus section, 4 of the cenchrus section, 2 of the hordeum section, 6 of the triticum, and 4 of respectively the lolium, the nardus, the lappago, and the ægilops sections. The second order consists of genera with subterminal spikes; and comprises 2 genera of the paspalum section, 10 of the chloris section, and 2 of respectively the spartina and the cynodon sections. The third order consists of genera with one-flowered panicles; and comprises 8 genera of the phalaris section, 11 of the agrostis section, 4 of the milium section, 3 of the stipa section, and 4 of respectively the calamagrostis, the chæturus, the leersia, and the oryza sections; but the calamagrostis, the leersia, and the oryza sections are named, from their structure or botanical characters, respectively arundinaceæ, asperellinæ, and hexandra. The fourth order consists of genera with many-flowered panicles; and comprises 19 genera of the avena section, 10 of the festuca section, 12 of the glyceria section, 5 of the cynosurus section, and 1 of the echinaria section. The fifth order consists of subbiflorous grasses; and comprises 9 genera of the panicum section, 2 of the ehrharta section, 2 of the actinochloa section, and 2 of respectively the tristegis and the anthoxanthum sections. The sixth order consists of villiflorous grasses; and comprises 19 genera, all in one section. The seventh order consists of bracteiflorous grasses; and comprises 3 genera, all in one section. The eighth order consists of declinous grasses; and comprises 8 genera, all in one section. The remaining genus, lygeum, is anomalous; and it is the same genus which Kunth's classification also renders anomalous. By far the most multitudinous sections in Link's classification are those of glyceria, avena, triticum, agrostis, panicum, festuca, phalaris, and hordeum; and these are numerous in the order in which we have named them, and jointly comprise rather more than seven-ninths of the total number of species. About one-fifth or ·2 of all the grasses in Britain belong to the glyceria section; about ·111 to the avena section; about ·102 to the triticum section; about ·082 to the agrostis section; about ·086 to the panicum section; about ·083 to the festuca section; about ·058 to the phalaris section; and about ·047 to the hordeum section.

The General Properties and Uses of the Grasses.—A few of the grasses have so unsocial a habit that no two species will grow together; but the vast majority are gregarious. The *Aira præcox*, on poor dry elevated sands, where it scarcely attains a total height of half a foot,—the *Ammophila arundinacea*, the *Elymus arenarius*, and the *Festuca rubra*, on the drifting sands of the sea-coast,—the *Glyceria fluitans*, the *Aira aquatica*, and the *Poa aquatica*, in water,—and the *Festuca ovina*, the *Festuca vivipara*, the *Poa alpina*, the *Nardus stricta*, the *Melica cærulea*, and some others, on heaths and in alpine situations,—are either wholly or principally solitary,—not, indeed, with the power of keeping exclusive possession of entire districts, entire hills, or even entire acres, but generally in the degree of forming separate tufts or patches, and of refusing to combine with other species within the limits of any one small space. But almost all the other grasses, particularly such as form good pasture, are so powerfully gregarious as to pine and languish except when they grow in considerable intermixture. Numerous observations made in the course of the Woburn experiments, and detailed by Mr. Sinclair in his Hortus Gramineus Woburnensis, clearly prove that any piece of soil which is cropped with a number of species of grasses will produce both better and bulkier produce than if it were cropped with only one or two species. "This," remarks Mr. Sinclair, in a separate essay, though so extending his phraseology as to include herbage-plants of other orders than the grasses, "is a curious and important fact, which has been unnoticed in previous works on the subject, as well as neglected in practice. If an acre of good land is sown with three pecks of ryegrass, and one peck of the clovers or trefoil, 470 plants only will be maintained on the square foot of such land; if a larger quantity of these seeds is sown, whether of these two species or of any other two, the extra number of plants vegetated, (which will certainly appear at first if the seeds are good,) will decay in a short time, and leave blank spaces to be filled up with weeds or spurious grasses, or in fact plants of different species, supplied by the soil, manure, or neighbouring hedges. But if, instead of two species of grasses, from eight to twenty different sorts are sown on the same soil, a thousand plants will be maintained on the same space, and the weight of produce in herbage and in hay increased in proportion."

Different species of grasses of the same natural habitat, of the same botanical tribe, and of the same adaptations and value for the purposes of herbage, have very different seasons of leafing, flowering, and maximum vigour; and in multitudes of natural pastures, so many species of successive periods of flowering are intermixed, that some one or other of them may, in almost any month of the year, be found in the perfection of its growth; while in a large garden or botanical arrangement of small specimens of multitudes of species, a succession of verdure and flowering throughout a great part of the year is strikingly apparent. "It is from this property of the natural grasses, connected with a combination of a considerable number of different species, which are always found in the most rich or fattening pastures, that the great superiority of these over artificial pastures, or of such as are formed of one or two species only, chiefly arises; and hence it is that the former, whether formed by nature in the course of many years, or by art in one, (by sowing the seeds of all the essential species, or by stocking the soil at once with a sufficiency of these plants, precluding thereby the introduction of spurious grasses or weeds,) are productive of a perpetual verdure and supply of fresh herbage unknown in artificial pastures, consisting of one or two species of plants only."

Some grasses, such as the *Poa annua*, inhabit all kinds of situations in almost all parts of the world; and some, such as the bamboo and the sugar-cane, inhabit only particular situations, in a particular climate, and within a very limited range of latitude. The greater number follow the general law of the whole vegetable kingdom, and distribute themselves in groups appropriated to the different zones and great natural divisions of the world; many are capable of cultivation in countries far distant from those in which they grow wild, or of acclimitation in latitudes considerably higher than those to which they naturally belong; and a large proportion of the indigens of Britain, or of any other limited and diversified territory, possess such differences of habit and predilection as to dispose themselves severally throughout all varieties of soil and situation, from the rocky surface of the mountain to the marshy or lacustrine expanse of the plain, and from the harsh and hungry debris of the moorland to the fond and fertile alluvium of the meadow.

"The shades of green colour in the herbage of the different grasses," remarks the writer already quoted, "are numerous and highly interesting, as may be proved by applying these varieties of tints to the test of the practical system of colours, by that eminent artist, G. Hayter, Esq., exhibited in the diagram inserted in the Hortus Ericæus Woburnensis, or by comparing at the same and at different seasons a select number of the leaves of distinct species. The colouring matter of grasses, when the saccharine and mucilaginous principles are in much less proportion, as is found in the leaves or lattermath late in autumn, in general accompanies the solution of the constituents of the nutritive matter. After the first evaporation of the solution, the green colouring matter may be destroyed and again recovered successively, by alternate solution and evaporation in water and in alcohol." The varieties in the shades of verdure, combine with the differences in the times of vigour, the differences in height, habit, soil, and appearance, and the advantages of experimenting with different species, upon different soils, with different manures, and in different methods of culture, to render a grass garden or a botanical arrangement of living grasses, an important and very interesting appendage to an improving estate or to the grounds of an agricultural school.

Several grasses, particularly *Ammophila arundinacea*, *Elymus arenarius*, *Poa maritima*, and *Festuca rubra*, possess such tenacity of life, such reptancy of root, and such power of extracting sustenance from the most famishing situation as enable them to grow and flourish on the sand-hillocks of the sea-shore, to arrest and bind into consistency the blowing sands of the beach, and to form a barrier both against the encroachment of the sea upon the coast, and against the desolating of the arable lands of the sea-board by clouds of sand-drift. The *Elymus arenarius*, the most robust of the four, occupies and secures the top of the sand-wreaths; the *Ammophila arundinacea*, secures and supports the sides; and the *Poa maritima* and *Festuca rubra*, straggle on the level sand, and work it into a basis for a solid accumulation. Plants of the creeping fescue have been found on the beach near Skegness, with roots extending six feet in the blowing sands.

The roots of many of the grasses are mucilaginous and demulcent; and those of several are well adapted to be used as medicine or as food. The roots of *Triticum repens*, in particular, contain a large quantity of nutritive matter, and might, with proper management, be turned to almost as good account as corn. See the article Couch Grass. The leaves of both *Triticum repens* and *Holcus arenaceus* are eaten by dogs to excite vomiting. The whole plant of *Anthoxanthum odoratum*, the roots of *Andropogon nardus*, the leaves of *Andropogon citratum*, and the culms of *Cymbopogon schœnanthus*, emit a delightful aromatic fragrance, and possess somewhat tonic properties.

The culms of a number of the grasses form a valuable material for bonnets, mats, and various ornamental articles; those of several perennial grasses are capable of being manufactured into both a finer and a more durable plait than has ever yet been produced in Italy; those of the common hardy cereal grasses are the chief material for littering the cattle of the farm-yard, and giving form and character to the indispensable composts of farm-yard manure; those of the common meadow grasses and of the ordinary sown-grasses of arable land combine with the leaves and the flowers of their own plants, and sometimes with the herbage of non-gramineous vegetation, to furnish much of the green fodder of summer and the whole of the hay of winter; those of the gigantic bamboo serve many purposes of house-structure and carpentry and general rural economy in the East; those of the sugar-cane, the *Sorghum saccharatum*, and some other species abound in sugary secretions, and either are or might be employed for yielding the common sugar of commerce; and those of the *Cynosurus cristatus*, though too fibrous and wiry to be useful as fodder, and too dry and uneconomical to be serviceable in any direct capacity to either man or beast, sustain the seeds of the plant till the severe and famishing season of winter, and then bear them aloft above the thick and dense carpeting of snow to feed many small and several large birds, which otherwise would pine with hunger or perish for want.

Both the culms and the leaves of the meadow and the pasture grasses constitute the proper or natural food of the herds and flocks of the farm. They constitute "that constant supply of essential food without which the more valuable domestic animals could not exist in any considerable number, or for any length of time, much less be brought to furnish us with the most important articles of clothing, and some of the most important parts of food. Meat, milk, butter, and cheese, wool and leather, with all the concomitant advantages, such as labour, manure, &c., which result to the cultivator of the soil from the use of cattle, would be lost without the cultivation of the perennial grasses." Most grasses, particularly before flowering, or at least before beginning to pass from their growing to their seeding state, possess a very perceptible degree of sapid juices; some are exceedingly rich in the saccharine element of these juices, some in the mucilaginous element, some in the saline element, some in the bitter extractive element, and some in various combinations of the several elements; any are nutritive or useful as herbage, just in the proportion in which they contain these elements in such amount and such combinations as to constitute the proper aliment of the graminivorous animals; and all of even the best differ widely from one another both in the intrinsic proportions of the elements of their juices, and in the relative proportion which the whole bear to the entire bulk of the herbage. The juice of the *Elymus arenarius*, for example, abounds in sugar; that of the upright variety of the *Poa compressa* consists almost wholly of pure mucilage; and that of the *Festuca pinnata* or of the *Holcus avenaceus* contains a very large proportion of saline matter and bitter extractive.

The seeds of the grasses are the food of all granivorous animals; those of the cereal grasses, wheat, barley, oats, maize, rye, rice, and millet, and of *Holcus spicatus*, *Holcus cernuus*, and *Poa abysinnica*, constitute a chief part of the food of man; and those of even the smallest and most seemingly worthless are capable of being used for the support of animal life. The smaller seeds are generally neglected, not because they differ in property from the large cereal kinds, but simply because they are so minute as scarcely to compensate the labour of gathering them. The seed of *Poa abysinnica* is very small, and is used as a substitute for wheat only in the peculiar circumstances, or in consequence of the peculiar tastes, of the people of Abyssinia. The seeds of *Arrhenatherum avenaceum*, *Avena fatua*, *Elymus arenarius*, *Glyceria fluitans*, *Digitaria sanguinalis*, *Zizania aquatica*, *Bromus secalinus*, and probably some other species, though seemingly ill-adapted for human food, have been readily eaten by man, and formed good substitutes for wheat, both in times of scarcity and in semibarbarous countries. "It is also to be noted," remarks Loudon, "that the particular uses for which the seeds of certain grasses are employed, are not peculiar to them, but may be obtained from all the others, with slight modifications. Thus beer is made, not only from barley, but also from wheat; spirituous liquors, not only from our European cerealia, but also from rice." In fact, a multitude of seeds, including those of very nearly all the grasses, principally consist of exactly the proximate principles of a large department of animal aliment, and either undergo naturally, or are capable of being made to undergo artificially, such chemical transmutations as will fit them for several purposes of luxury or general economy. See the articles GERMINATION and SEED. The seeds of the annual grasses are larger and heavier than those of the perennial; and the seeds of the fibrous-rooted grasses are heavier and more fertile than those of the creeping-rooted; so that the former, in each case, are the fittest for food and the most suitable for cultivation. All grass seeds, excepting ergotted ones, and under certain circumstances those of some varieties of oat and those of *Lolium temulentum*, are thoroughly wholesome. Seeds affected with ergot are dreadfully deleterious; but they derive all their malignity and poison either from a minute fungus, or from some awfully transforming operation of disease, and cannot be regarded as a true exception to the wholesomeness of grass-seeds. See the article ERGOT. The seeds of oats possess an exciting or stimulating power, and are capable of producing effects too exhilarating to comport with sound nutrition; but they owe this peculiarity, not to anything in their albumen or the matter of their meal, but to an aromatic principle which lies imbedded in the husk, and is soluble in alcohol, and ought never, at the mill, to find its way into intermixture with the farina. The seeds of *Lolium temulentum*, in every ordinary condition, are powerfully narcotic and very seriously deleterious, and constitute a true exception, probably the only true one, to the perfect wholesomeness of undiseased grain-seeds; yet even they become wholly or at least comparatively wholesome, either when long exposed to wet, or when used in the manufacture of beer, or when baked up with wheaten flour into bread. See the article DARNEL.

The Indigenous Grasses of Britain.—Only about 125 species of grasses, exclusive of varieties, grow wild in Great Britain and Ireland; only about 22 or 23 of these are peculiar to England or Ireland, or do not occur wild in Scotland; and a considerable proportion of the whole are either rare, very coarse, exceedingly innutritious, or otherwise of little or no value, or in some instances actually annoying to the cultivator of the soil. The *Poa annua* is the most common of all, thrives in every kind of soil, occurs at all elevations between sea-level and 4,000 feet above it, flowers almost through the whole year, and appears to be eaten and relished by every kind of herbivorous animal, whether bird or brute; the *Festuca ovina* abounds on most of the Scottish mountains, constitutes a principal portion of their verdure, plays a chief part in producing the finely flavoured mutton of the lofty pastures of Benlawers, Benvoirlich, and other alpine sheepwalks; and the *Alopecurus pratensis*, the *Dactylis glomerata*, the *Schedonorus pratensis*, and one or two other species, besides being plentiful, and constituting a large portion of our natural pastures, are considerably superior to the best of the hardy exotics, or at all events to ryegrass, in the nutritiousness and general excellence of their herbage.

The indigenous grasses demand emiment attention on account of both their utility and their beauty. They enter most largely into the carpeting of the great majority of the permanent grass-lands of the kingdom; they compose nearly all the natural herbage of our hills, our valleys, and our woodlands; and they constitute almost the sole food of many an upland flock, and the principal sustenance of a very large proportion of all the flocks and herds of Britain. "How interesting, too, is it to acquaint ourselves with the tribe of plants which form the principal material in the green vesture which clothes the surface of our island—which perform so important a part in the colouring of the picture which Nature spreads out before us—so as to render the British Islands, in this respect, the admiration of foreigners when they approach our shores. The olive groves of the sunny south, notwithstanding all the pleasing associations they conjure up, have yet a grey, sickly, and melancholy hue; even in Valumbrosa, you can scarcely find a piece of green sward whereon to recline; the magnificent masses of foliage in a tropical clime either entirely usurp the soil, or are broken into patches, leaving here and there stretches of arid sand, on which the eye cannot rest with pleasure. But here the surface, while it is left perfectly open, is covered with a uniform and continuous carpet, kept by frequent showers in a state of such vivid green that it is not surprising Great Britain should have been compared to a gem; its verdure contrasting so beautifully with the surrounding ocean that it may well be likened to an emerald set in silver."

The indigenous grasses which, jointly with the creeping vetch, constitute the principal spring and summer herbage of the best natural pastures of Britain, are the annual meadow-grass, the meadow fescue, the meadow foxtail, the meadow oat-grass, the meadow cat's-tail, the common ryegrass, the sweet-scented vernal grass, the field brome-grass, the round cock's-foot, and the tall oat-like soft grass; those which, jointly with the yellow vetch, the white clover, and the perennial red clover, constitute the principal summer and autumn herbage of these pastures, are the rough-stalked meadow-grass, the woolly soft-grass, the crested dog's-tail, the meadow-barley, the yellow oat-grass, the smooth fescue, and the hard fescue; and those which, jointly with the yarrow, constitute the most vigorously growing autumn verdure of these pastures, are the marsh bent-grass, the creeping wheat-grass, and the creeping agrostis. Other plants, indeed, particularly the ribwort plantain, the sorrel-dock, and the common buttercup, usually form part of the verdure of such pastures; but, excepting in some degree the ribwort, or under a pressure of hunger from the exhaustion of the proper herbage, these plants are not ingredients but pests and weeds of the pastures. The grasses which, jointly with white clover, bird's-foot clover, sainfoin, larger bird's-foot clover, the daisy, and some other plants, constitute the principal verdure of the natural pastures of elevated lands and of dry and sandy soils, are the annual meadow-grass, the upright annual brome-grass, the alpine meadow-grass, the alpine foxtail, the fine bent, the snowy bent, the lobed bent, the purple bent, the rock bent, the brown bent, the crested brome-grass, the soft brome-grass, the nodding brome-grass, the barren brome-grass, the sheep's fescue, the wall fescue, the viviparous fescue, the glaucous fescue, the pubescent fescue, the flat-stalked meadow-grass, the reflexed meadow-grass, the meadow-barley, the wall-barley, the waved hair-grass, the crested hair-grass, the blue melic-grass, the green panic-grass, the blood-coloured panic-grass, the feather-grass, the slender foxtail, the hairy oat-grass, the upright mat-grass, the blue moor-grass, and the panicled cat's-tail grass. The principal indigenous grasses, which grow in company with mosses, heaths, rushes, eriophorums, and other coarse plants, on bogs, peaty moors, and marshy grounds, are the water hair-grass, the turfy hair-grass, the marsh bent, the brown bent, the awned creeping bent, the awnless brown bent, the creeping-rooted bent, the smaller-leaved creeping bent, the white bent, the water meadow-grass, the knee-jointed foxtail, the tall fescue, and the flote fescue.

The Periods at which the Grasses ripen.—The usual flowering time of each species of the principal hardy grasses, whether indigenous or exotic, is noted in the account of it in our article on the genus to which it belongs. But the precise ripening periods of all the principal grasses, under exactly the same circumstances of climate and cultivation, and in their relations or successions to one another, are a matter of interest and importance to every well-informed farmer, and were carefully ascertained by Mr. Sinclair as the result of ten years' observation and experiment. The precise dates which he exhibits, of course, are applicable only to the precise kind of climate and situation in which his experiments were conducted, and state merely the average time even in these; yet they can easily be accommodated to widely different climates and situations, and they show with the utmost accuracy the order of succession in which the grasses mature their seeds. According, then, to Mr. Sinclair's table, the annual meadow-grass, *Poa annua*, ripens its seed from the 10th of April till the frosts of winter; the sweet-scented vernal grass, *Anthoxanthum odoratum*, from the 10th till the 20th of June; the soft annual brome-grass, *Bromus mollis*, from the 12th till the 20th of June; the clove-pink-leaved hair-grass, *Aira caryophylla*, and the bitter vernal grass, *Anthoxanthum amarum*, from the 15th till the 20th of June; the one-flowered melic-grass, *Melica uniflora*, the alpine meadow-grass, *Poa alpina*, the narrow-leaved meadow-grass, *Poa angustifolia*, and the blue meadow-grass, *Sesleria cœrulea*, from the 18th till the 24th of June; the spring millet-grass, *Milium vernale*, from the 18th till the 25th of June; the sweet-scented soft grass, *Holcus odoratus repens*, about the 20th of June, though generally abortive; the meadow foxtail-grass, *Alopecurus pratensis*, about the 30th of June; the barley-like fescue, *Festuca ovina hordeiformis*, from the 20th of June till the 20th of July; the small-flowered oat-grass, *Avena parviflora*, from the 4th till the 10th of July; the long-flowered brome-grass, *Bromus longiflorus*, from the 4th till the 13th of July; the Hungarian fescue, *Festuca pannonica*, and the hard wheat-grass, *Triticum nardus*, from the 4th till the 17th of July; the glaucous fescue, *Festuca glauca*, from the 4th till the 24th of July; the field brome-grass, *Bromus arvensis*, about the 7th of July; the jointed foxtail grass, *Alopecurus geniculatus*, from the 7th till the 26th of July; the smooth meadow-grass, *Poa pratensis*, from the 10th till the 17th of July; the bulbous meadow-grass, *Poa bulbosa*, about the 11th of July; the woolly soft-grass, *Holcus lanatus*, from the 12th till the 24th of July; the common quaking-grass, *Briza media*, from the 12th till the 20th of July; the creeping fescue-grass, *Festuca rubra*, from the 12th till the 25th of July; the perennial ryegrass, *Lolium perenne*, about the 15th of July; the yellow oat-grass, *Avena pubescens*, from the 15th till the 25th of July; the blue meadow-grass, *Poa cœrulea*, the roof brome-grass, *Bromus tectorum*, the hooded horn of plenty, *Cornucopia cucullatum*, the reflexed meadow-grass, *Poa distans*, the rigid meadow-grass, *Poa rigida*, and the rough-stalked meadow-grass, *Poa trivialis*, about the 16th of July; the crested dog's-tail, *Cynosurus cristatus*, from the 16th till the 30th of July; the round-headed cock's-foot, *Dactylis glomerata*, and the wood fescue, *Festuca dumetorum*, from the 19th till the 30th of July; the glaucous cock's-foot, *Dactylis glaucescens*, the striped cock's-foot, *Dactylis variegata*, Russel's ryegrass, *Lolium Russellianum*, and the upright brome-grass, *Bromus erectus*, about the 20th of July; the Welch fescue, *Festuca Cambrica*, and the upright vetch, *Vicia stricta*, from the 20th till the 30th of July; the wall brome-grass, *Bromus diandrus*, the large-panicled brome-grass, *Bromus maximus*, the flat-spiked brome-grass, *Bromus unioloides*, the wood-millet, *Milium effusum*, the brome-like fescue, *Festuca bromoides*, the ryegrass-like fescue, *Festuca loliacea*, and the linear-spiked dog's-tail, *Cynosurus erucæformis*, about the 21st of July; the American variety of the striped cock's-foot, *Dactylis variegata Americana*, about the 22d of July; the gigantic brome-grass, *Bromus giganteus*, the slender oat-grass, *Avena fragilis*, and the meadow oat-grass, *Avena* *pratensis*, about the 24th of July; the common meadow cat's-tail, *Phleum pratense*, and the lesser meadow cat's-tail, *Phleum pratense minus*, about the 25th of July; the eastern oat-grass, *Avena orientalis*, from the 25th to the 30th of July; the water hair-grass, *Aira aquatica*, about the 26th of July; the early hair-grass, *Aira præcox*, and the sea-green meadow-grass, *Poa cæsia*, about the 27th of July; the ciliated melic-grass, *Melica ciliata*, from the 27th till the 31st of July; the sheep's fescue, *Festuca ovina*, about the 28th of July; the crested hair-grass, *Aira cristata*, and the capon's-tail fescue, *Festuca myurus*, about the 29th of July; the crested brome-grass, *Bromus cristatus*, the slender fescue, *Festuca gracilis*, the hard fescue, *Festuca duriuscula*, the slender variety of the sheep's fescue, *Festuca ovina tenuis*, the slender-leaved fescue, *Festuca tenuifolia*, the meadow fescue, *Festuca pratensis*, the viviparous fescue, *Festuca vivipara*, the sand canary-grass, *Phalaris arenaria*, the nerved meadow-grass, *Poa nervata*, the wood meadow-grass, *Poa nemoralis*, the bulbous-jointed cat's-tail, *Phleum nodosum*, and the fertile meadow-grass, *Poa fertilis*, about the 30th of July; the crested hair-grass, *Aira cristata*, and the giant lyme-grass, *Elymus giganteus*, about the 2d of August; the decumbent meadow-grass, *Poa decumbens*, and the spelt wheat-grass, *Triticum spelta*, about the 3d of August; the slender wheat-grass, *Triticum tenue*, the dog's wheat-grass, *Triticum caninum*, and the common bent, *Agrostis vulgaris*, about the 4th of August; the upright mat-grass, *Nardus stricta*, and the many-flowering brome-grass, *Bromus multiflorus*, about the 5th of August; the flat-stalked oat-grass, *Avena planiculmis*, the glaucous meadow-grass, *Poa glauca*, the procumbent meadow-grass, *Poa procumbens*, the wood-bent, *Agrostis sylvatica*, and the tall fertile fescue, *Festuca elatior fertilis*, about the 6th of August; the Philadelphian lyme-grass, *Elymus Philadelphicus*, from the 6th till the 20th of August; Bauhin's melic-grass, *Melica Bauhini*, about the 9th of August; the hedgehog lyme-grass, *Elymus hystrix*, the jointed lyme-grass, *Elymus geniculatus*, and the barren brome-grass, *Bromus sterilis*, about the 10th of August; the foxtail-like fescue, *Festuca alopecuroides*, from the 10th till the 23d of August; the golden oat-grass, *Avena flavescens*, about the 20th of August; the meadow barley-grass, *Hordeum pratense*, about the 21st of August; the lanceolate fine-panicled bent, *Calamagrostis lanceolata*, from the 21st till the 30th of August; the slender rye-grass, *Lolium tenue*, the narrow-leaved brome-grass, *Bromus angustifolius*, and the spear-panicled brome-grass, *Bromus lanceolatus*, about the 24th of August; the winged brome-grass, *Bromus pinnatus*, from the 28th of August till the 5th of September; the brown bent, *Agrostis canina*, and the bundled-leaved bent, *Agrostis vulgaris fascicularis*, about the 29th of August; the couch-grass, *Triticum repens*, about the 30th of August; the awnless brown bent, *Agrostis canina mutica*, about the 5th of September; the foxtail-like oat-grass, *Avena alopecuroides*, from the 5th till the 12th of September; the white or couch bent, *Agrostis alba*, from the 6th till the 15th of September; the fiorin grass, *Agrostis stolonifera latifolia*, about the 8th of September; very many in the middle and latter parts of September; and nine or ten principal ones in the first half of October. All the best hardy grasses, therefore, might, as to the time of the ripening of their seeds, be distributed into an early summer group, a late summer group, and an autumn group, or into three summer groups, for the last half of June and the two halves of July, and three autumn groups, for the months of August, September, and October.

The Comparative Nutritiousness of some of the Principal Grasses.—The feeding value of the straw, the hay, and the seeds of some of the principal grasses, whether viewed in comparison with one another, in comparison with plants of other orders, or in reference to the principles and proportions of their alimentary constituents, is variously exhibited in the articles on FATTENING, on FODDER, and on FOOD, and in some other articles. But the results of Sinclair's researches, though, in a chemical respect, far less accurate and penetrating than those relied on in these articles, abundantly deserve a special notice, in this place, both on account of their strictly exhibiting the comparative values of the principal grasses among themselves, and of their connecting classes or groups of the values with certain external characters which are cognisable by the most superficial observation.

The quantity of nutritive matter in 1920 grains of the leaves of each of some of the principal grasses, in the early part of April, is as follows,—120 grains in tall oat-like soft grass, 110 in darnel-like fescue, 102 in long-awned sheep's fescue, 96 in meadow foxtail, 96 in meadow fescue, 94 in tall fescue, 90 in creeping soft-grass, 88 in crested dog's-tail, 84 in smooth awnless brome-grass, 80 in round panicled cock's-foot, 80 in woolly soft-grass, 80 in meadow cat's-tail, 80 in rough-stalked meadow-grass, 76 in nerved meadow-grass, 70 in perennial ryegrass, 70 in fertile meadow-grass, 70 in smooth fescue, 68 in wood meadow-grass, 62 in wood fiorin, 54 in common quaking grass, 52 in sweet-scented vernal grass, and 42 in creeping bent or Irish fiorin. The nutritive matter, too, is not less diversified in composition than different in amount; and that of the meadow-foxtail comprises 64 per cent. of starch or mucilage, 8 of sugar, and 28 of extractive and saline principles,—that of the meadow fescue comprises 59 per cent. of starch or mucilage, 20 of sugar, and 20 of extractive and saline principles,—that of ryegrass comprises 65 per cent. of starch or mucilage, 7 of sugar, and 28 of extractive and saline principles,—that of meadow cat's-tail comprises 74 per cent. of starch or mucilage, 10 of sugar, and 16 of extractive and saline principles,—that of cock's-foot comprises 59 per cent. of starch or mucilage, 11 of sugar, and 30 of extractive and saline principles,—that of meadow oat-grass comprises 80 per cent. of starch or mucilage, 10 of sugar, and 10 of extractive and saline principles,—and that of fiorin comprises 55 per cent. of starch or mucilage, 5 of sugar, and 40 of extractive and saline principles.

The proportion of the nutritive matter of any grass to its whole bulk, of course, is very different in the green or flowering state of the grass from what it is when the grass becomes converted into hay; and the relative amount of it in both conditions, in the case of a great number of the most common species, will be found stated in our articles on the several genera of the grasses. The chemical constituency of the nutritive matter, also, materially differs in the three states of flowering, of seeding, and of aftermath. "I found in all the trials I made," says Sir Humphrey Davy, "the largest quantity of truly nutritive matter when the seed was ripe, and least bitter extract and saline matter; most extract and saline matter in the autumnal crop; and most saccharine matter, in proportion to the other ingredients, in the crop cut at the time of flowering." In the case of the round panicled cock's-foot, *Dactylis glomerata*, which he states for illustration, the nutritive matter of the crop cut at the time of flowering consisted of 18 per cent. of sugar, 67 of mucilage, and 15 of extractive and saline principles, that of the crop cut at the time of the seed being ripe consisted of 9 per cent. of sugar, 85 of mucilage, and 6 of extractive and saline principles, and that of the aftermath crop consisted of 11 per cent. of sugar, 59 of mucilage, and 30 of extractive and saline principles. Yet all analyses of grasses or other forage plants made by Davy, Sinclair, and their contemporaries must now be cautiously regarded as mere approximations; for, not only were the plots too small and the circumstances of soil and climate and culture too limited for eliciting the comparative powers of the different plants, but the very method by which the nutritive values were determined, though as good as the chemical science of that day could suggest, would not, in the present state of that science, be received as accurate or conclusive. Shier, therefore, omits from his edition of Davy's Agricultural Chemistry the appendix of analyses and comparative values.

The external characters which Sinclair ascertained to be associated with a greater or less secretion of some one or other of the nutritive principles, are so numerous as not only to maintain classification into groups, but in most instances to give several criteria to each group. Sugar and mucilage are comparatively abundant in grasses which have large-jointed culms, thick and succulent leaves, and downy-husked flowers; and the sugar is generally in excess in such of these as have a light glaucous colour. Extractive matter is comparatively abundant in grasses which have small-jointed culms, thin, flat, rough, light-green leaves, and pointed flowers in either a spike or a spike-like panicle. Gluten and mucilage are comparatively abundant in grasses which have many-jointed culms, smooth and succulent leaves, spiked or closely panicled flowers, and large and blunt florets; and sugar is next in proportion to the mucilage in such of these as have a glaucous colour and woolly florets. Mucilage and extractive are comparatively abundant in grasses which have the points of their culms smooth and succulent, their flowers panicled, and their florets pointed or awned. Extractive and saline principles are comparatively abundant in grasses which have tall culms, flat and rough leaves, panicled flowers, and thinly scattered, pointed, or long-awned florets. Extractive and mucilage are comparatively abundant in grasses which have strong creeping roots, flat and rough leaves, and spiked flowers.

The Comparative Adaptations of some of the Principal Grasses.—Some of the hardy grasses, when artificially raised from seed, in the manner of field culture or "laying down to grass," speedily die out or are smothered and dislodged by indigenous grasses or other indigenous plants; and others take such a firm and sturdy possession of the soil as to flourish for years, and maintain a thorough resistance of every effort of indigenous plants to displace them. Of a large assortment of such grasses raised on rich and tenacious soil in the agricultural garden of Dalkeith Park, and experimentally cultivated there in 1834 and in the three succeeding years, the following species and varieties continued, at the end of the four years, to retain possession of the ground,—some, however, more completely than others, or the first in the list more completely than the last,—*Aira cæspitosa lutescens*, *Arrhenatherum avenaceum*, *Festuca tenuifolia*, *Festuca ovina*, *Festuca duriuscula*, *Festuca loliacea*, *Bromus giganteus*, *Poa pratensis*, *Holcus lanatus*, *Festuca pratensis*, *Festuca elatior*, *Festuca heterophylla*, *Agrostis stolonifera*, *Alopecurus pratensis*, *Agrostis alba*, *Agrostis capillaris*, *Agrostis dispar*, *Aira cæspitosa*, *Poa nemoralis nervosa*, *Poa nemoralis*, *Phleum pratense*, and *Dactylis glomerata*. But a number of others, including some of the best known and most useful, were found, in the course of the same experiments, to be unable to retain long possession of the ground. The *Poa annua*, for example, though in most natural situations, and on almost every description of virgin soil or waste ground or exposed spot, keeping up a constant succession of germinating, growing, flowering, and seeding, from early spring till the frosts of winter, yet, when artificially sown on good soils, becomes almost entirely replaced by more powerful grasses and other indigenous plants; *Agrostis spica-venti*, also an annual grass, though tall and strong enough to maintain a far sturdier contest than the preceding, dies out in the open ground in Scotland in consequence of being too ender to bring its seeds to a sufficient degree of maturity; *Agrostis rupestris* or *Agrostis setacea*, has the same fault as *Agrostis spica-venti*, and seems at best to possess a habit of only biennial duration; the annual ryegrass, the common perennial, Molles', Pacey's, Stickney's, and Devonevers varieties of *Lolium perenne*, "being all allowed to ripen without shaking their seeds each ear," says the report, "have gone off in the order named, so that at present," in 1838, "the ast does not occupy more than one-third of the surface which it originally covered, and the first variety had to be resown each spring, having usually about four-fifths perished;" "*Lolium talicum*," adds the report, "possesses about the ame permanency as the common perennial ryegrass under similar treatment, being inferior in his respect to the four varieties last-named;" *Elymus sibericus*, in consequence partly of the oil not being sufficiently light and dry, and partly of the unfavourable character of the weaher during the latter half of the period of trial, was fully as much displaced as the more permaent varieties of ryegrass; *Avena flavescens*, *Anhoxanthum odoratum*, *Cynosurus cristatus*, *Aira exuosa*, and *Poa trivialis* were partly subdued y the unfavourableness of the soil, and partly vergrown and dislodged by stronger plants; nd both the short and the long seeded varieties f *Glyceria fluitans*, were partly dislodged by inigenous grasses, "which," says the report, "is asily accounted for from their naturally growng in wetter soils, as well as from their compaatively dwarf or prostrate habit, and the straggling inoffensive fibrous nature of their roots."

All grasses, of course, as well as all other plants, hether annual, biennial, or less or more perennial, are quite at home, and able to retain ossession for an indefinite length of time, in cirumstances precisely suitable to their natural abits; and they begin to evince hardihood or nstability, or to exhibit comparatively high or low owers of coping with the disturbing influences of ultivation, either when removed to situations ery different from those which are natural to hem, or when subjected to such treatment from rt and such rivalry or antagonism from neighouring plants as more or less contrast with the reedom of their wild condition. In any average ssortment of grasses, therefore, one group of pecies may be most stable in one set of circumances, another group of species may be most able in a very different set of circumstances nd a third group of species may be equally, or most equally stable, in both the sets of circumances. An experiment, like that in Dalkeith ark derives its main value from being conducted nearly the average climate of Great Britain, nd upon soil closely akin in character to that of e best varieties of arable land; and cannot, ithout either great calculation or very serious risk of error, be allowed to guide the judgment in reference to any very colder or very hotter situation than Dalkeith, or to either arenaceous, moorish, chalky, or morassy soils. But a series of experiments in Surrey, by Mr. Taunton of Bridgewater, on account of having been conducted during eight years, on a comparatively extensive scale, on several somewhat widely different kinds of soil, and in a certain degree supplementarily to the celebrated Woburn experiments, afford a wider range of guidance, and deserve to be particularly noticed.

All varieties of ryegrass sown by Mr. Taunton, though including several which had been loudly praised to him as true perennials, became utterly extinguished both in beds and in field culture, and both on chalk soil and on his deepest and richest loamy sand. "My observation of some particular meadows and pastures in different parts of the kingdom," says he, "induces me to believe that some varieties of *Lolium* are in some soils indigenous and permanent; but my experience warrants me in dissuading from that profuse and promiscuous use of ryegrasses called perennial, which their cheapness and certainty of growing too much recommend in ordinary practice, unless by a previous experiment of several years it shall have been ascertained that the particular variety employed will prove permanent on that particular stratum and soil which it is desired to convert to grass." *Phleum pratense*, which both its cheapness and its valuable qualities occasioned to be largely employed in the experiments, totally vanished from poor calcareous heights, almost totally vanished from both chalky soil and rich loamy sand, and, though plentifully maintaining its ground on clay lands, suffered even there much diminution of height and size. *Phleum nodosum*, though a native of some very bare chalk soils, died out from the experiment ground, but probably owed its failure to the choking effect of too thick sowing; and cock's-foot, the common perennial meadow-grass, and several other species, cannot maintain their ground when too thickly sown. *Phalaris arundinaceus*, held its station with nearly as much vigour as on its native lofty, moist, clayey land; and it also flourished and retained all its strength as a meadow-grass on low clay soils. *Alopecurus pratensis*, *A. arundinaceus*, and *A. Tauntoniensis*, when mixed in a clay meadow with a dark moory mould on the surface, maintained their height, bulk, and abundance as well as any other grasses, or even better than some or all; and, when grown in rows for seed, on deep sandy loam, where springs occasionally break out, were extremely luxuriant; but, when grown on dry chalky soil, the *Tauntoniensis* wholly disappeared, and the other two became considerably weak and scanty. "I find it difficult to determine," says Mr. Taunton, "which of these species affords the most bulky crop: for where they each partook of the benefit of the water, all were extremely copious. One character common to all attracted my attention, namely, that though they stood till late in the summer, not having been wholly cut till after the middle of July, and after all the seed had fully ripened, yet none of the radical leaves had decayed or withered, but all continued green, and the scythe easily swept close to the level of the ground; whereas, at the same season, a large proportion of the radical leaves of many of the other large grasses, such as the cocksfoot and tall fescues, were already withered and dead, presenting an obstacle to the scythe in cutting and somewhat impairing the quality and colour of the hay made from them. I could not view even this imperfect essay, without reflecting to what a valuable purpose any tract of springy moist loamy sand, such as, under aration, is extremely troublesome to the cultivator, may be converted, by sowing it with a selection of grasses in which the foxtails should predominate."

Numerous species and varieties of agrostis, inclusive of all the kinds of fiorin, were sown; but, excepting *Agrostris canina*, all died out. *Cynosurus cristatus* remained throughout the experiments, but became more or less scanty according to the predominance of silicious or calcareous matter. *Avena pratensis* and *Avena pubescens* not only continued but increased. *Avena flavescens* also endured; but, in spots where the soil was not argillaceous enough to encourage a luxuriant growth, it diminished and became insignificant; "yet," remarks Mr. Taunton, "it is so rich in its qualities, and so universal a citizen of the word, that there is no soil, from the lightest calcareous loam to the stiffest clay, into which I would not introduce it, where I wanted to produce a permanent turf." *Dactylis glomerata* maintained its bulk in most of the situations where it was tried; but it dislikes both dense and very wet clay and any soil which is quite destitute of clay; and it did not succeed either on pieces of very stiff clay land, or on the elevated parts of the chalky downs. *Dactylis cynosuroides* remained throughout the eight years on deep, silicious sand in a thicket of oak, but became crowded and apparently weakened by exhaustion. *Festuca elatior fertilis* was the largest and most vigorous grass in the collection, and maintained its superiority in the light soil as well as in the strong clay. *Festuca pratensis* abounded and increased on comparatively good parts of calcareous loamy sand. *Festuca ovina hordeiformis* was remarkable, not only for its durability, but for the largeness of its produce and for the thickness and fineness of its turf. *Festuca heterophylla* and *Festuca dumetorum* also succeeded excellently on the hills. *Festuca arundinacea* survived on calcareous loamy sand, but suffered from the want both of clay and of moisture. *Bromus littoreus* became harsh and curled in its foliage during hot weather, and dwindled away, even in the most favourable circumstances, into comparative scantiness. *Elymus caninus* retained its ground; but *Elymi canadensis, maximus, arenarius, geniculatus*, and *virginicus* disappeared. *Holcus lanatus*, not only kept its place, but mischievously luxuriated over the lighter parts of sandy soils. *Holcus mollis* maintained its place on a soil of chalk intermixed with alluvial flint gravel. *Hordeum pratense* maintained its growth and possessed considerable value upon clay meadows, and even survived on calcareous sandy loam. *Tritica elongatum, medium, littoreum*, and *rigidum*, held their place, but diminished in both size and strength as the soil became less soft and porous. "Of the *Poas*," says Mr. Taunton, "many have disappeared; but I am gratified by discovering that the rich *Poa angustifolia* retains its position as well on light dry calcareous loamy sand as on moist calcareous sandy soil, and on loamy clay; but, from its propensity to increase by its running roots, it soon starves itself in a very moderate bulk, if sown in beds alone; and the most valuable use of this grass probably will be found to consist in the sparing introduction of the seeds among other grasses. Where *Poa nemoralis* had been planted on trenched soils in my plantations, which have now grown so thick as to have smothered all other grasses under them, this Poa has increased and overspread the whole space: its rich nutritious quality, its beautiful and perpetual verdure, and above all, this quality of flourishing under a dense cover of trees, appear to me to render it peculiarly valuable for the particular purposes of rendering ornamental, and also of turning to a profit, the site of grown up plantations and thick groves, which usually are in a state of complete nakedness. On several beds of considerable extent, whereon I had raised the *Poa nemoralis* on open ground, it was nearly overpowered and exterminated by other grasses. *Poa virens* continues to flourish on a spot of clay land where I had originally sown it."

Some grasses which yield great bulk of produce and possess a considerable or even large proportion of nutritiveness, are hastily condemned by multitudes of farmers on account of their coarse appearance. Cattle select their food by an instinctive recognition of wholesomeness, universally and most benignly conferred on them by the all-benevolent Creator,—and they treat grasses, not at all according to their appearance, but wholly according to their odour, their flavour, and their intrinsic properties; but unreflecting farmers select or approve the herbage of their farms almost solely by the eye, and are liable to reject with scorn any newly imported grass which seems any way akin in bulk and massiveness to the bulrushes or the sedges. "I have often observed, in showing even very intelligent farmers my collection of grasses," says Mr. Gorrie of Annat, "that if any species shewed strength of stem, with luxuriance of herbage, and consequently promising extraordinary weight of forage, that species was, without hesitation, pronounced coarse and unworthy of further attention, till the opinion of a horse or a cow, as a qualified reference, was taken on the subject." Among the useful grasses which have been more or less neglected on account of their coarse appearance, are *Festuca elatior*, *Elymus sibiricus*, *Lolium Italicum*, *Glyceria aquatica*, and some of the very promising species which have been recently introduced from America.

Mixtures and Sowing of Grass Seeds.—Mixtures of grasses, except in very rare instances and upon some of the poorest and most refractory kinds of land, are vastly superior to solitary species; mixtures of a considerable number of kinds, or at least of from three to nine or ten, are generally much superior to mixtures of only two; and mixtures which include one or two species of other herbage plants, particularly of clovers, the vetch group, or of yarrow, are often decidedly superior to mixtures consisting wholly of grasses. But widely different mixtures, partly as to the several species employed and partly as to the proportions of each, are required for respectively argillaceous, arenaceous, calcareous, moorish, and morassy soils; and widely different mixtures, as to at once the habits, the proportions, and the natural duration of the species, are required also for respectively water-meadows, dry alluvial meadows, the lea lands of arable ground, the permanent pastures of the hills, and a conjoint cropping in the alternate husbandry. Several or even many equally good mixtures, too, as to both species and proportions, might be made for almost any one of the classes of either soils or purposes; and one set of mixtures might be selected to succeed best in the earlier periods of growth, and another set to succeed best in the later stages of growth, while the two might be equally productive upon the average of their duration or within the cycle of the purpose which they are raised to serve. Some species of grasses, likewise, are incomparably more exacting than others as to pulverization of soil and artificial fertilization with manures; some permit an easy access to troublesome weeds, while others most sternly resist them; some extract from the soil a considerable proportion of the principles which are peculiarly needed by corn crops, while others make no inroad upon these principles, and largely contribute to the accumulation of others; and many mixtures might, with reference to these several classes, be so composed as to develop adaptation, not less to the time of their actual growth, than to the precurrent circumstances of the land, and to the anticipated or intended circumstances of after-cultivation. Mixtures of grasses among themselves, and particularly mixtures of grasses in combination with other forage plants, are thus capable of being made vastly more numerous than almost any farmer has ever imagined,—and all in perfect harmony with the wisest economy, and in wonderful and interminable subserviency to variational rotations, and to the utmost niceties of all peculiarities of either soil, situation, or purpose. We, therefore, cannot attempt even to frame an index to the number or groups of mixtures which farmers might find profitable; and must content ourselves with merely mentioning a few of the more obvious ones which have been recommended by skilful and well-known experimentalists.

Rich old pasture land returned to grass, after having been broken up and subjected to a course of arational cropping, may be sown, at the rate of five bushels of seeds per acre, with a mixture of meadow fescue, meadow foxtail, round cock's-foot, tall oat-like soft grass, ryegrass, meadow cat's-tail, crested dog's-tail, yellow oat, meadow oat, hard fescue, smooth-stalked meadow-grass, fertile meadow-grass, nerved meadow-grass, marsh-bent, fiorin, creeping vetch, cow clover, and white clover. This mixture is an artificial improvement on that which naturally grows on the best pastures, and simply rejects the worst plants of the natural mixture and adds one or two prime ones; and it was experimentally tried by the late Mr. Sinclair, with the express view of ascertaining the difference between its produce and that of the natural pasture. The piece of grass ground broken up for it was cropped during five years with successively oats, potatoes, wheat, carrots, and wheat; it was found, at the end of the five years, to have suffered a very considerable diminution of its organic constituents; it was then, in preparation for the grass-seeds, manured and pulverized; and, between the time of their being sown and the commencement of frost, it received a top-dressing of a dry compost of lime, vegetable mould, and rotten farm-yard-manure. The produce of the first summer was cut and weighed on the 1st of July, and was found to be one-eighth greater than that of the original or natural grasses on the same piece of ground; the produce of the first aftermath was found to be one-fifth less than that of the original grasses; and the produce of the whole of the second year was found to be one-eighth greater than an average year's whole produce of the original grasses.

Sandy upland soils, which are broken up for the double purpose of exterminating some of their weeds and least valuable herbage, and of fertilizing themselves by processes of pulverization and by adding to them clay or marl, may, according to Sinclair's recommendation, be sown with a mixture of 3 pecks of barley-like sheep's fescue, 3 pecks of cock's-foot, 1 peck of crested dog's-tail, 2 pecks of yellow oat-grass, 1 peck of ryegrass, 1 peck of flat-stalked meadow-grass, 1½ peck of various-leaved fescue, 2 pecks of hard fescue, 1 lb. of lesser bird's trefoil, and 3 lb. of white clover.—Or any average hill land, for permanent sheep pasture, may, according to the recommendation of Mr. Stirling of Glenbervie, be sown with a mixture of 9 lb. of fox-tail, 2½ lb. of cock's-foot, 3½ lb. of meadow fescue, 4½ lb. of hard fescue, 4½ lb. of Italian ryegrass, 3 lb. of red clover, 4 lb. of yellow clover, 4 lb. of white clover, 8 lb. of Timothy-grass, 2 lb. of rib-grass, and 1 lb. of yarrow.—Or, according to the recommendation of Messrs. Gibbs of London, light soils for permanent pasture may be sown with a mixture of 3 lb. of perennial ryegrass, 3 lb. of Italian ryegrass, 2 lb. of meadow fox-tail, 4 lb. of cock's-foot, 2 lb. of meadow fescue, 2 lb. of hard fescue, 1 lb. of rough-stalked meadow-grass, 2 lb. of smooth-stalked meadow-grass, 3 lb. of wood meadow-grass, 2 lb. of sweet-scented vernal grass, 2 lb. of Timothy grass, 4 lb. of red clover, 5 lb. of white clover, and 3 lb. of perennial red clover; and heavy soils for permanent pasture may be sown with a mixture of 4 lb. of perennial rye-grass, 4 lb. of Italian rye-grass, 2 lb. of meadow fox-tail, 5 lb. of cock's-foot, 3 lb. of meadow fescue, 1 lb. of hard fescue, 2 lb. of rough-stalked meadow-grass, 1 lb. of smooth-stalked meadow-grass, 4 lb. of wood meadow-grass, 2 lb. of sweet-scented vernal grass, 4 lb. of Timothy-grass, 5 lb. of red clover, 6 lb. of white clover, and 4 lb. of perennial white clover. The reasons for intermixing such short-lived plants as Italian ryegrass and biennial red clover, are that they spring rapidly up, afford herbage during the first year for stock, and then die out to give place for the diffusion and the increased bulk of the other plants, and that, on the other hand, the more durable plants, if sown without them, must either be sown so thin as not to afford herbage for stock in the first year, or so thick as to incommode and strangle one another in the second and following years.

For dry lands, a good addition to all judicious mixtures of true grasses and clovers, be the mixtures what they may, is from 2 lb. to 4 lb. of sheep's fescue to every acre of elevated sheep pasture, and 10 oz. of yarrow to every acre of light low land. But for heathy or moory lands, which have been pared and burned, or which have been otherwise operated upon with a view to the improvement of their capacities for herbage, only the cheapest and most facile mixtures can be afforded. When the lands are less than 500 feet of altitude above sea level, and are tolerably dry, a sufficient mixture, along with a corn crop, may be either 25 lb. of mixed hay seeds, and 5¼ lbs. of white clover, or 17 lb. of mixed hay seeds, 3¼ lb. of Italian ryegrass, and 5¼ lb. of white clover,—and without a corn crop, may be either 32 lb. of mixed hay seed, 6½ lb. of white clover, and two-thirds of a bushel of rye or barley, or 21 lb. of mixed hay seeds, 4¼ lb. of Italian ryegrass, 6½ lb. of white clover, and two-thirds of a bushel of rye or barley. If the lands are wet, part of the mixed hay-seeds may be substituted by from 14 lb. to 34 lb. of Timothy grass, from 2 lb. to 3¼ lb. of rough-stalked meadow-grass, from 1 lb. to 2 lb. of meadow soft-grass, and from 1 lb. to 2 lb. of fiorin; and if the lands are 500 feet or upwards of altitude, above the level of the sea, especially if they are dry and intended for sheep pasture, the whole mixture may consist of 2¼ lb. of sheep's fescue, 1 lb. of zigzag hair-grass, 2 lb. of hard fescue, and 2 lb. of perennial red clover.

Pasture-land, when intended to produce the greatest possible quantity of good herbage during the months of winter and early spring, obviously requires to be sown with a peculiar selection of grasses; and if it be of any ordinary quality, it may, according to the recommendation of the late Mr. Sinclair, be advantageously sown with a mixture of 4 pecks of cock's-foot, 3 pecks of meadow fescue, ¾ of a peck of meadow cat's-tail or true Timothy-grass, 1 peck of broad-leaved bent or fiorin, 2 pecks of tall oat-like soft grass, 2 pecks of burnet, 6 lb. of perennial red clover, and 8 lb. of white clover. If the land have very heavy soil, and be constantly depastured with cattle, some tall fertile meadow-grass ought to be added to the mixture; and if the land have a poor soil and possess considerable elevation, some woolly soft grass ought to be added.

A water meadow, with a light soil, may be sown with a mixture of 2¼ lb. of fiorin, 1¼ lb. of meadow foxtail, 1 lb. of loliaceous fescue, 2½ lb. of meadow fescue, 1½ lb. of tall fescue, 2¼ lb. of floating glyceria, 6 lb. of Italian ryegrass, 7 lb. of perennial ryegrass, 1 lb. of reed canary-grass, 2 lb. of Timothy-grass, 2¾ lb. of rough-stalked meadow-grass, and 2 lb. of greater bird's-foot trefoil. A water meadow, with a heavy soil, may be sown with a mixture of 2¾ lb. of fiorin, 1¾ lb. of meadow fox-tail, 3 lb. of loliaceous fescue, 2½ lb. of meadow fescue, 2 lb. of tall fescue, 2¾ lb. of floating glyceria, 6 lb. of Italian ryegrass, 7 lb. of perennial ryegrass, 1½ lb. of reed canary-grass, 3½ lb. of Timothy grass, 3¼ lb. of rough-stalked meadow-grass, and 2 lb. of greater bird's-foot trefoil. A water meadow, of medium quality of soil, may, of course, be sown with quantities intermediate between those for the light soil and the heavy soil. In all cases, also, a bushel of rye-seeds per acre may be sown to shelter the seedling meadow grasses; and when the expense of the mixtures is felt to be an objection, this may be lessened to the amount of from 4s. to 5s. per acre by excluding the meadow fox-tail, and taking only half the quantity of the greater bird's-foot trefoil. "Under most circumstances, however," says Mr. Lawson, the recommender of the mixtures, "it will be advisable to retain the full quantity of the greater bird's-foot trefoil, not only from its being the best adapted of the clover tribe for withstanding excess of moisture, but also from its attaining to full maturity at a late period of the season, when the growth of the grasses generally becomes less vigorous."

A mixture for sowing with a grain crop in the alternate husbandry, whether the forage is intended for one year, for two years, or even for three years, has very generally consisted of simply perennial ryegrass, red clover, and white clover, varying in proportion according to the nature of the soil, the circumstances of the culture, and the judgment or caprice of the farmer. Sainfoin and lucerne have also been favourites in some parts of England; the hop-like trefoil, *Medicago lupulina*, under the misnomer of yellow clover, has, somewhat absurdly, become a favourite in some parts of the lowlands of Scotland; and when only one year's forage is wanted, the main or the sole reliance is very commonly on annual ryegrass and annual red clover. But of late years, other plants, both of the grasses, and of other orders, have, with various degree of success, come into use with very many enterprizing farmers. The Italian ryegrass, on account of the rapidity of its growth, the sweetness of its taste, and the bulk of its produce, seemed to claim chief and enthusiastic favour; but it so speedily overtops almost everything else with which it is sown, as, after fair trial, to be generally pronounced unsuitable. Such of the plants as are of slower growth and longer duration, however, abundantly deserve attention in all cases in which forage for two or for three years is required. Farmers have, on the whole, paid good and praiseworthy attention to the improved sowing of permanent pastures; but they are unaccountably and miserably inadvertent to the improved sowing of the temporary grass lands of the alternate husbandry. "For three years' pasture on good soils," says Mr. Lawson, "the substitution of 2 lb. of *Dactylis glomerata*, the common rough cock's-foot, for about 3 lb. of the perennial ryegrass, will be found advantageous; while in sheep pastures the addition of 1 lb. per acre of parsley seed, *Petroselinum sativum*, would also be attended with good results; and in certain upland districts, established practice will point out the introduction of 2 lb. or 3 lb. of rib-grass, *Plantago lanceolata*. In proportion to the retentiveness of heavy soils, as well as for those of a peaty nature, *Phleum pratense*, the meadow cat's-tail, should be added, to the extent of 2½ lb. to 3½ lb. per acre." Parsley may perhaps appear to some persons a strange ingredient in sheep pasture; but, in addition to its own nourishing properties, it serves as a condiment to all the other herbage, and it is highly relished by sheep, and never allowed by them to run to seed.

An experiment, reported in the Second Volume of the Quarterly Journal of Agriculture, though made so long ago as the year 1828, may throw some light on the propriety of using a more compound mixture than the common one in the alternate husbandry. In the beginning of April, an area of 14 Scottish acres or 17·656 imperial acres, consisting of heavy soil, though not of a clay loam, incumbent on a retentive subsoil, and then in a state of high cultivation, and sustaining a crop of spring-sown wheat a few days above ground, was sown with 140 lb. of red clover, 65 lb. of white clover, 28 lb. of hop-like trefoil, 2½ bushels of Dickson's variety of perennial ryegrass, 8 bushels of cock's-foot, 4 bushels of hard fescue, and 85 lb. of the greater meadow cat's-tail; and an area of one Scottish acre in the centre of the same field, was at the same time sown with 10 lb. of red clover, 5 lb. of white clover, 2 lb. of hop-like trefoil, and 2 bushels of ryegrass. In autumn, when the wheat crop was reaped, the grass plants showed thick in the ground; and afterwards, they grew vigorously, and were at times depastured with cattle. On the 1st of next May, the acre of trefoils and ryegrass, in consequence of the early growth of the latter, made the greatest show of herbage; but during the progress of the month, the clover overtopped the ryegrass, and gave a hue to the acre which distinguished it, to even a very distant observer, from all the rest of the field; and before the end of the month, the crop of the general mixture equalled the clover and ryegrass crop in height,—the culms of the cock's-foot, the hard fescue, and the cat's-tail rising in succession, and greatly exceeding in tallness those of the red clover. Toward the end of June, the one acre, owing to the clover having overpowered the ryegrass and been beaten down by the weather, looked to be exceedingly luxuriant,—and the rest of the field, in consequence of the lofty cock's-foot and cat's-tail overtopping and concealing the strength of the red clover, looked to be considerably less luxuriant; but, at the mowing of the two on the 29th of June, the crop of the one acre or of the mere ryegrass and clover, was found to be inferior to the crop of the general mixture, as to at once thinness on the ground, lightness on the scythe, and both the bulk and the quality of the hay. "The second crop or aftermath of the mixed grasses, both in earliness and quantity of produce, was superior to that of the clover and ryegrass. In the middle of August, a portion of the aftermath from both crops was cut, and the produce of the third crop of the mixed grasses was still superior to the clover and ryegrass. But towards the end of October, the aftermath, springing from time to time from the second cutting of clover and ryegrass, obtained a superiority of colour, and perhaps also in produce, over that on the other parts of the field. * * The cock's-foot throughout the season, put forth new leaves with rapidity after being cut with the scythe, and produced culms to the hay-crop only. The fescue planted thinly, and also grew rapidly after being cut. The cat's-tail was later in producing flower-stalks than the other grasses used in the experiment, and, after being cut, did not put forth new leaves so rapidly as the cock's-foot and fescue; but, in every instance, it produced numerous culms, which blossomed at the same time as the red clover, and when a part of the field was four times mown, yielded a rich crop of culms to the last cutting."

The best depth of cover for agricultural grass seeds, is a matter of great importance, and yet has obtained surprisingly little attention from agriculturists. An experiment respecting it was made, in 1842, by Messrs. Drummond of Stirling, and the results of it afterwards exhibited at the agricultural show in Edinburgh; and another and more decisive experiment was made in the following year by Mr. Stirling of Glenbervie, and deserves to be here particularly noted. Mr. Stirling sowed a barley-field of 15 acres all over with red and yellow clover, and the third parts of it with respectively Italian ryegrass, Pancy's ryegrass, and Timothy-grass; he had, in preparation for the grass-seeds, rolled two-thirds of it after the barley was finished; and at the sowing of the grass-seeds, he bush-harrowed one-half of the rolled portion, and grass-seed-harrowed the other half of the rolled portion and the whole of the unrolled portion. "I was surprised," he says, "at the small apparent difference of the crop; but, on closer inspection, the shallower sown seemed thicker planted, and the deeper to have stooped more from being thinner. It was with a view to settle this point that it seemed necessary to count the plants which would grow at each depth." He put the question to trial under an ingenious yet simple set of appliances, and included in the experiment some other plants than those which he had sown in the field; and he makes use of the following diagram to represent both his plan and its results.

No. 1, Section of Cover ¼ inch deep.				No. 2, Sec. of Cover from 0 to 3 in. deep.												
Weight sown. s.	Average Inch.	Kind of Plant Experimented on.	Total of each kind.	0	¼ Inch.	½ Inch.	¾ Inch.	1 Inch.	1¼ Inch.	1½ Inch.	1¾ Inch.	2 Inches.	2¼ Inches.	2½ Inches.	2¾ Inches.	Total of each kind. 3 In.
8	29	*Lolium perenne*, (Perennial Ryegrass,) -	348	29	30	27	19	16	19	14	12	11	9	8	4	198
15	23	.. *Italicum*, (Italian Ryegrass,) - -	276	24	21	20	13	13	10	11	8	9	6	5	5	145
7	25	*Dactylis glomerata*, (Cock's-foot,) - - -	300	30	22	15	15	10	9	7	5	2	...	...	...	115
13	26	*Festuca elatior*, (Larger Fescue,) - - -	312	29	24	20	16	13	13	11	9	4	2	1	...	142
9	27	... *pratensis*, (Meadow do.) - - -	324	28	28	16	12	10	6	9	4	2	2	...	...	117
6	29	... *heterophylla*, (Various leaved do.)	348	31	23	20	18	12	9	6	4	1	...	...	...	124
6	30	... *duriuscula*, (Hard do.) - - - -	360	30	23	10	15	10	8	5	3	1	...	...	...	114
13	16	*Alopecurus pratensis*, (Meadow Fox-tail,)	192	17	17	16	15	12	7	6	3	1	...	...	...	94
3	44	*Phleum pratense major*, (Timothy-grass,) -	528	52	39	37	19	16	15	7	5	...	...	...	...	190
9	19	*Poa nemoralis sempervirens*, (Evergreen wood Mead-Grass,) - - - - - -	228	24	14	4	1	...	...	...	...	...	...	...	...	43
6	21	*Plantago lanceolata*, (Rib-grass,) - - -	252	22	25	19	17	14	11	10	8	6	2	...	...	134
4	16	*Trifolium pratense*, (Red Clover,) - - -	192	17	16	14	11	11	8	4	4	...	...	...	...	85
3	12	... *repens*, (White do.) - - - -	144	13	11	6	4	3	1	...	...	...	...	...	...	38
10	8	*Medicago lupulina*, (Yellow do.) - - -	96	12	10	8	6	4	2	...	...	...	...	...	...	42
	325		3900	358	303	241	181	144	118	90	65	37	21	14	9	1581

"The seeds," says Mr. Stirling, "were treated in the following manner:—Two boxes, five feet ten inches by one foot, were filled with soil; No. 1 to within a quarter of an inch of the top; No. 2 to the top on the one side, regularly sloping to within three inches of the top of the other. They were then divided across by slips of wood two inches broad, so as to leave fourteen spaces of two inches by one foot in each box. The same weight of seed was sown in each box, the slips were removed, and the boxes filled to the top with soil. They were placed in a green-house for the first ten days, to prevent the risk of heavy rains, which would have crusted the surface. This may have caused the seeds to spring from a greater depth than would have happened under ordinary circumstances. The quantities sown, as marked in the first column of grains of sixteen to the drop, were such as each ought to have produced nearly the same number of plants, had the seed continued as good as when sown and counted in spring, with the exception of the Timothy, of which nearly a double number was sown, from the difficulty of distributing so small a quantity equally. A quarter of an inch is too deep for the *Poa nemoralis*, as it grew freely when scarcely covered. The other information to be obtained from the experiment, beyond that for which it was made, is, that it requires double the weight of Italian ryegrass seed to produce the same number of plants that it does of common—that, in this case at least, the clovers and fox-tail seeds, kept over a summer, would have been dear at half price—and that the total of the second column of No. 1 is less than the first column of No. 2. I may also mention that, in a similar experiment tried this spring, 1844, and now growing here, the number of plants appear to diminish in the same proportion as shown in No. 2. They are generally most vigorous at three-quarters of an inch of depth, with the exception of cock's-foot, rib-grass, and red clover, which do well to an inch and a-half. Whether this difference arises from these depths being most suitable, or from the smaller number of plants, must be ascertained in a future experiment, by thinning them out to a single row."—See the articles Grass Lands, Pasture, Seed, Agricultural Seeds, Sowing, Sowing-Machines, and Rotation of Crops.—*Sinclair's Hortus Gramineus Woburnensis.—Parnell's Grasses of Scotland.—Lawson on the Cultivated Grasses.—Donaldson on Manures, Grasses, and Farming.—Martyn's Letters on Botany.—Loudon's Encyclopædia of Plants.—Loudon's Hortus Britannicus.—Withering's Botany.—Lawson's Agriculturist's Manual.—Knowledge Society's British Husbandry.—Davy's Agricultural Chemistry by Shier.—Transactions of the Highland Society.—Quarterly Journal of Agriculture.—Hunter's Georgical Essays.—The Bath Papers.—The Farmer's Magazine.—The Gardener's Magazine.—Lisle.—Stillingfleet.—Sproule.—Low.—Doyle.—Stephens.*

GRASS-LAMB. See Lamb.

GRASS LANDS. Lands producing herbage for the feeding of farm stock. They comprise three great divisions,—permanent pasture, water-meadow, and artificial or rotational grass; and have reference to the support of stock, whether by depasturing, by soiling, or by hay-feeding,—whether by means chiefly of proper gramineous herbage, or of the large or even prominent accompaniment of other forage plants,—and whether with reference exclusively to the support of stock, or collaterally to the arational purposes of either the alternate husbandry or the convertible husbandry. All the principal parts of the subject of grass lands, and even some of the subordinate ones, form the topics of the whole of some separate articles and of large portions of others,—particularly of the articles Pasture, Meadow, Irrigation, Aftergrass, Grasses, Feeding of Cattle, Fattening of Cattle, Hay, Sowing, Draining, and Rotation of Crops. We shall, therefore, do no more in the present article than draw an outline of the whole subject, and fill up any small point or two which does not elsewhere occur to be fully noticed.

Grass lands, even when viewed quite apart from the mighty connexion which two great and important classes of them have with arational husbandry, serve the momentous purposes of largely contributing to the maintenance of the due proportion of vital air in the atmosphere, of mainly contributing to preserve the equilibrium between the electricities of the atmosphere and the electricities of the world's crust, of elaborating out of the gases of the atmosphere and the salts and earths of the soil a large portion of the aliments which support the animal kingdom, and of providing mediately for the use of man a main part of the animal products, which, after shorter or longer processes of preparation, constitute his food, his clothing, or his implements of economy. They, therefore, are quite as worthy of attention as lands under aration; and to a skilful agriculturist, they also form the subject of hundreds of cares and methods and investigations for their proper management and their improvement.

Mountainous grass lands or upland pastures may, in multitudes of instances, be greatly improved by the draining of the soil, by top-dressing with lime, by the artificial addition of the most suitable herbage plants, and even by a process of breaking up, mineral manuring, and total re-sowing; and they ought, in all instances, to be enclosed and subdivided,—to be rather understocked than overstocked,—to enjoy alternations of rest and use, by the periodical shifting of the flock from one enclosure to another,—to be freed, and kept free, from noxious or useless vegetation,—to have the droppings of solid excrement upon them promptly spread or scattered over considerable breadths of surface,—and to be depastured either with only one species of stock, or with cattle previous to sheep, and never with sheep previous to cattle.

Grass lands suitable for the convertible husbandry, or pastures which are neither too poor to produce remunerating crops of corn nor too rich to be more remunerating under grass than under corn, ought to experience the alterative of tillage, and require particular management both in relinquishing and in resuming their grasses. When the surface is wet, it ought to be drained before being broken up; and whether wet or dry, it ought, as soon as it is broken up, to be dosed with either lime, chalk, or good calcareous marl. When the surface is neither friable nor shallow, and has a sward which cannot soon be rotted, it ought to be first pared and burned, and afterwards subjected to the plough; and when it is deep, and has a coarse and vivacious turf, and cannot conveniently be pared and burned, it ought to be double ploughed,—one plough taking off a sod of about three inches, and a following plough taking up the proper depth of the mould or soil below, and superimposing it on the inverted surface sod,—or one compound plough of special construction, performing at one bout the whole operation. The proper course of crops during the period of aration depends partly on the manner of the breaking up, and partly on the nature of the soil; but, both in itself and in its accompanying processes of culture, it must possess complete power to destroy all the coarse plants, whether grasses, rushes, or whatever else, which formerly deteriorated the turf. All the green crops of the course, except in the case of turnips upon strong wet soil, ought to be consumed on the ground; either all the straw of the white crops, when converted into manure, or some equivalent for it, containing the same or similar elements of vegetable nutrition, ought to be returned to the spot; and all processes of fallowing, whether of green-fallowing or of bare-fallowing, requisite to the thorough destruction of weeds and poor grasses, to the full play of the forces of natural chemistry, and to the complete and very fine pulverization of the soil, ought to be unsparingly performed. In returning the land to grass, a corn crop may or may not, according to circumstances, be sown along with the grasses,

—and when one is sown, oats ought to be preferred on peaty soils, and barley on all other soils; the grass-seeds ought to be deposited by means of the grass-sowing machine, or if sown by hand, they must be sown on a quite calm day, when the soil is comparatively dry, and all the species not closely similar in weight, bulk, and other mechanical characters, must be sown successively to one another, each constituting a sowing of itself; and preparatory to the whole process, the land, if not naturally well drained, must be rendered dry and porous by art, "for all the best sorts of grasses abhor a wet bottom when they are young, and will not root deep enough in it to bear the vicissitudes of the seasons, and, not increasing by the roots as they ought to do, will die when they have perfected their seed, and leave the land bare." In the first autumn, the young grasses ought to be depastured but very slightly, and only in dry weather; and in the following spring, the land ought to be heavily rolled, in order to compress the soil deeply and closely around the roots.

Water-meadows,—salt-marshes,—grass lands which are liable to be flooded,—grass lands in the vicinity of large towns, where the produce is always in demand and of high market value,—low-lying grass lands in the valleys of the chalk downs and of mountainous districts, where old and good pasture is scarce, and possesses peculiar value for yielding early and late food to the flocks of the adjacent uplands,—and rich grass lands, with clayey, strong loamy, or powerfully alluvial soils, not easily scorched by the summer's drought, abounding in the most nutritive herbage, able to feed sheep and cattle into very fine condition and up to a great weight, producing in milk cows copious secretions of rich, butyraceous, finely-flavoured milk, possessing eminent adaptation for preserving the hoofs of flocks, boasting a great variety of both species and character of the sweet, succulent, and nutritious grasses, yielding a constant succession of herbage throughout the year, and maintaining their fertility during an indefinite period, without the aid of manure or of any other costly appliance,—all such grass lands ought to be kept continually in grass, ever untouched by the plough or by anything which would break or injure their sward.

Grass lands, of such medium quality as to require the stimulus of manure, and so situated as to be easily capable of aration, in some instances ought not, but in most instances ought, to be subjected to the convertible husbandry. When, as in Norfolk, all the arable land of a district is light, and sheep are both bred and fed under the care of one owner, a proportion of permanent pasture on every farm is essential; when lands in grass pay only vicarial tithes, and are remunerating as sheep-pastures, but would pay rectorial tithes in aration, and yield uncompensating returns of corn, they require, in all common sense, to be kept permanently in grass; when the resources of an arable farm are incompetent to yield more than an ordinary or average amount of winter forage, one or two enclosures of permanent pasture may be necessary, not only for aiding the routine support of sheep and cattle, but as a resource in any emergency of severe and prolonged frost in spring or of scorching drought in summer; and even when the practice of the convertible husbandry over every acre of a farm might be decidedly profitable for the tenant within the limits of his period of lease, but would be unprofitable to the landlord or depreciatory of the aggregate value of the land beyond the limits of that period, the retention of a fair proportion of it in permanent pasture is demanded by the principles of true and comprehensive economy.

But the vast majority of grass lands which require manure, and might be cereally cropped, belong to none of the categories now specified, and ought to be regularly treated upon the principles of either the convertible or the rotational husbandry,—either alternating a cycle of grass with a cycle of aration, or relinquishing the character of permanent pastures altogether, and producing grass only in the one or two or three years artificially appropriated to it in a regular and continuous course of cropping. "The objections to the division of a farm, one-half into permanent grass, and the other half into permanent tillage," remarks Sir John Sinclair, "are very great. The arable is deteriorated by the abstraction of the manure it produced, if applied to enrich the grass; while a part of the manure thus employed is wasted; for spreading putrescent substances upon the surface of a field, if done at an improper season, is to manure, not only the soil, but the atmosphere. The miserable crops of corn produced, where this system prevails, sufficiently prove its mischievous consequences. So injurious is this mode of management, that of impoverishing the arable land for the sake of the grass, that in the opinion of experienced farmers, the landlord loses one fourth of the rent he otherwise would get. for every acre thus debarred from cultivation; while the public is deprived of 3¾ bushels of grain, for every stone of beef or mutton thereby obtained. This is a point that cannot be too much inculcated, in a country increasing in population, and which finds it necessary to import foreign grain for the maintenance of its inhabitants. For, with the exception of rich pastures, arable land is, on an average, superior to grass land, with respect to furnishing articles of human food, in the proportion of three to one; and consequently every piece of land, unnecessarily kept in grass, the produce of which will only maintain one person, is depriving the community of food, capable of maintaining two additional members. * * Landlords, in many parts of England, are apt to be apprehensive that their interests may suffer from a change of system; and it is much to be lamented, that the law scarcely does afford them adequate protection for their property against tenants who are inclined to break through their engagements. Were it not for this circumstance, the interests of the landlord might be sufficiently guarded against injury, by judicious covenants, and by prescribing an improved management. A regular system of convertible husbandry might thus be established, by which the value of landed property would not only be greatly augmented, but the true interests of the country be most essentially promoted." An inferiority of the new grass to the old, is sometimes experienced after the period of tillage, and has often been urged as the grand objection to the conversion of old turf into arable land; but this inferiority, in every instance in which it occurs, is merely accidental to the convertible system, and arises altogether from foolish or miserly mismanagement,—either from the non-destruction or the positive cherishing of weeds and other coarse herbaceous indigens, or from the exhaustion of humus by over-cropping with grain, and affording stinted supplies of manure, or from a bad selection and sparce application of grass-seeds. But when even comparatively poor grass lands are calcareously manured, thoroughly broken up, completely tilled, as amply supplied with humus and salts in the shape of farm-yard compost as they are deprived of them in the shape of food to the grain crops, and then wisely returned to grass under a proper sowing of a proper mixture of grass seeds, they are certain to produce a sward very decidedly superior in all the desirable qualities of pasture to that which they formerly possessed.

The advantages, on the other hand, of subjecting arable land to regular alternations of grass, are also very great. See the articles FALLOW, ALTERNATE HUSBANDRY, and ROTATION OF CROPS. "It cannot be doubted," says Sir John Sinclair, "that if one-fourth part of the land which at present is sown with corn were properly laid down in grass, for the purpose of feeding stock, until it became again fit to bear abundant crops of grain, it would be of the greatest benefit both to the farmer and to the public, as the other three-fourths would be better manured, more easily cultivated, and would produce as much for consumption as the whole now does. The advantages to be derived from the alternate or convertible husbandry, cannot be too much dwelt on. If one million of acres of old tillage land were gradually laid down into herbage, and the like extent of old pasture broken up, and put under judicious rotations, it would probably be the means of supplying the public market with not less than two millions of stones of beef and mutton, additional, and three millions of quarters of grain. Under that system also, when judiciously conducted, the crops are always abundant, and the soil is kept in a constant state of increasing fertility. A considerable capital is necessarily required, to commence and carry it on; and it must occasion some trouble in its execution; but these are circumstances which indispensably accompany every improved system. If one-half of a farm be kept under artificial grasses and other green crops, as much live stock may often be supported and fattened upon their produce, as if the whole farm were pastured; while the other half, enriched by the large quantity of dung produced by the consumption of these crops, will furnish as much disposable produce for supplying the market with the various sorts of grain, as if the whole farm had been sown with culmiferous crops. Hence the superior advantages and profit derived from a conjunction of stock and of corn husbandry; by the union of which, wherever such a plan is practicable, British husbandry can be more substantially improved, than by any other means that has hitherto been suggested."

The manuring of grass lands, whether they are middle-rate permanent pastures, or long-continued lea-grounds, or thin-swarded and unthriving artificial grasses, is, in many instances, an operation of considerable nicety. Proper liquid-manure, indeed, is both peculiarly appropriate and very easily applied. See the article LIQUID MANURE. Light dressings of soot, wood ashes, peat ashes, malt-dust, or any similar substance, if applied in dry weather and during a firm state of the ground in February or March, are likewise very suitable, and often highly beneficial; yet even these are sometimes inappropriate, and ought never to be used till their efficacy upon the particular soil or field requiring manure is ascertained by experiment. Unmixed putrescent farm-yard manure, if applied at some seasons of the year, and in certain states of the land and the weather, will almost wholly be dissipated in the atmosphere or washed away with surface-water; and even a compost of such a nature as to comprise the powers of farm-yard manure, and yet to arrest or lessen their volatility, renders any pasture unsuitable for milk-cows, and requires, in any circumstances, to be applied with caution and skill. The best month for it is October, and the best conditions an open state of the soil and the prospect of immediate or speedy rains; so that it may not be evaporated by drought or sunshine, and may percolate with the rain into the pores and interstices of the soil, and find as rapid and deep and complete a lodgement as possible around the roots of the grasses. An old practice in the north of England is to cart the manure to the pastures in the time of frost; and this is recommended by the seemingly sagacious considerations of not injuring the sward, and of giving employment to the otherwise idle teams: but it is really a practice of great absurdity. So long as the frost lasts, the land cannot possibly profit from the manure; and when a thaw arrives, the wash from rain or from melting snow, carries off all the portions of it which either liquefy or dissolve; and the soil, for days, continues too much frost-bound to admit any of the more solid portions, and afterwards it is so saturated with the moisture of the thaw as still to possess no capacity for manure.

The growth of mosses, particularly of hypnums and sphagnums, often infests the finer kinds of grasses, and sometimes increases with amazing rapidity and force. The grand remedy for this evil, and that which in almost every instance will secure the greatest ultimate profit, especially when the mosses are much diffused or have rapidly appeared, is promptly to plough up the ground, and subject it to a course of tillage. Another remedy, scarcely inferior in power to the preceding, but sometimes of a nature rather to be a correlative of it than a substitute of it, is to drain the land, and apply to it rich composts. When the land is so very wet and so much impoverished that subsoil-draining and the complete incorporation of strong manure are requisite for its proper cure, it ought to be, at the same time, improved by the destruction of its present sward, the pulverization and cleansing of its soil, and the production of a new sward by artificial sowing; but when it is so slightly wet and so little impoverished that surface-draining and mere top-dressings are sufficient, it, of course, needs not be broken up. Another remedy, or at least a palliative, which sometimes serves as a remedy, is to harrow and cross-harrow with such a weight upon the harrow as to keep the tines at a depth of from one inch to two inches, and afterwards to make a sprinkling of grass-seed, and to apply a small top-dressing of lime. Another palliative, which sometimes operates as a remedy, destroying the moss and bringing up abundance of grass, is to feed sheep with oil-cake, and allow them to depasture on the land.

The weeding of grass lands is essential to true economy. Many grass lands may be seen in Ireland, and not a few even in Britain, so overrun with rushes and sedges, or with docks, thistles, ragweed, knapweed, and other bulky and unprofitable intruders, that not more than one-half of their whole area, if even so much, is occupied with useful herbage; and so long as they continue in such a condition, they are at least half lost to the occupant, and are every season becoming seriously worse. Rushes and sedges can be exterminated only by thorough draining and its proper accompanying operations. Ragweed may speedily be exterminated by the cheap and easy means of depasturing with sheep, who eat down the young plants of it to the surface of the ground as soon as they appear. Docks and thistles may be exterminated by cutting down the plants, when passing into bloom, or before they form their seed, with a weeding-hook for a series of years; and they ought to be cut down also from the surrounding hedges, the neighbouring roads, and any adjacent waste places whence they might convey their seeds upon the breeze into the field. Numerous small weeds, and especially coarse and comparatively unprofitable grasses, can be exterminated only by the ploughing up and general improving of the land.

Every grass-field ought to be cleared of stones and of all kinds of rubbish and accumulations which can in any way obstruct the growth of the grasses. Stones ought to be picked up when the ground is dry and firm, and to be thrown directly into an attendant cart; or at worst, they should be collected into heaps till the state of the field can allow a cart to pass over it without injury to the sward. Sticks, bushes, and spray which have fallen from hedge-pruning or been strown by the wind, ought all to be removed. The cones of anthills are always important enough to demand attention, and sometimes serious enough to require very special care. See the article Ant. Mole-hills ought to be scattered and spread with a spade or a bush-harrow; and then they will not only cease to be a nuisance, but will improve the land. All spots left bare or partially vacant by the removal of weeds, stones, or rubbish, ought to receive a sufficient sprinkling of grass-seeds.

The rolling or the scarifying of grass lands, according to the condition of the sward, is an important operation. The rolling is proper when the sward has a free, open, unembarrassed texture, such as indicates growth and health in all or most of the plants which compose it; and it serves the purposes of smoothening and consolidating the surface, of protecting the roots of the grasses from the injurious effects of drought, of preventing the formation of anthills, and of promoting the growth of valuable herbage. But it must be judiciously performed under suitable circumstances of the land, else it will bruise the herbage, damage the roots, close up the pores of the soil, and in general do vastly more harm than good. It ought, if circumstances permit, to be performed about a fortnight before the field begins, for the season, to be depastured; and it ought never, in any circumstances, to be performed except when the sward is quite dry, and when the soil or the seat of the roots is sufficiently yielding to prevent the bruising of the leaves or the rupture of the roots beneath the pressure of the roller. Sandy and semi-elastic lands may be rolled at any time when their sward is dry; but clay lands may be advantageously rolled only when any little lumps or inequalities on their surface crumble down with the pressure of the foot, and are not flattened and consolidated, but enter softly and wholly into combination with the surrounding soil. But whenever a sward is in the compact and tenacious condition which is technically called hide-bound, rolling, under even the most favourable circumstances, would injure rather than improve it, and scarifying must be practised instead, to loosen the surface, to give the roots new facilities for absorbing food and producing herbage, and, if thought desirable, to serve also as a powerful precurrent aid to the beneficial operation of a top-dressing of manure. An easy method of scarifying is to employ either harrow-teeth or a plough with mere coulters, so as to tear or cut the whole surface.

An important rule in the management of grass lands—one whose violation always indicates either monstrous ignorance or scandalous wastefulness—is never to allow them to be depastured when, either from saturation with rain or from other causes, they cannot firmly resist the pressure of the feet of the flocks; and this rule peculiarly applies to all clay-lands and heavy loams. "When land of a retentive quality is pastured by cattle or horses in wet seasons," remarks Sir John Sinclair, "it receives much injury from their feet. Every step they take leaves an impression, which rain fills with water, and then the hole stands full like a cup. This wetness destroys the herbage, not only in the hole, but that also which surrounds it, while at the same time the roots of the grasses, as well as the ground, are chilled and injured. No good farmer, therefore, will permit any cattle to set a foot on such land in wet weather, and few during the winter months on any consideration."

The mowing of very rich old grass lands ought seldom or never to be practised, for it so injures the most delicate of the grasses or deteriorates the aggregate excellencies of the sward that the pastures seldom fatten stock so well afterwards as before, and sometimes lose a considerable proportion of the feeding celebrity which they may have acquired. The annual mowing of rich grass lands frequently invites an attack of the mosses, encourages the appearance or the spread of other weeds, weakens some and kills others of the finer grasses, diminishes or exterminates white clover, affords facility to the coarse and rank grasses to extend and usurp, and renders the whole sward comparatively thin and innutritious; and whenever the practice has been so long or so mischievously pursued as to induce even a portion of these evils, it ought to be entirely abandoned, and the lands used entirely for depasturing, and subjected to the requisite processes of improvement, during at least a sufficient time to subdue all their weeds, and effect a complete reappearance of all their finer grasses. Whenever rich lands are mown, whether occasionally or annually, the mowing ought to take place early in the season, and the aftermath ought to be fed but lightly, and only by sheep.

The plan of alternately mowing and depasturing grass lands of medium quality, or such as require occasional doses of manure, and are most profitably treated on the principles of the convertible husbandry, has been a subject of great contest of opinion among intelligent agriculturists. "By adopting that system," says the writer already quoted, "a farmer, it is said, may go on longer without the application of manure, but his fields in the end will be ruined by it. It is contended, that to maintain a proper quantity of stock, the land must be accustomed to keep it, particularly in the case of sheep,—that where land has been used to the scythe, if manured for pastures, it will often produce more grass, but that grass will not, *cæteris paribus*, support so much stock, nor fatten them nearly so well,—and that old pasture will not produce so much hay, as land that has been constantly mowed,—for each will grow best as they have been accustomed to grow, and will not readily alter their former habits. On the other hand, it is asserted, that many experienced farmers prefer the system of feeding and mowing alternately, as they find that, under that system, the quality and quantity of the hay have been improved, and the pasturage in the alternate year has been equally sweet and productive. It is a most important point to ascertain in what cases cutting or feeding is most beneficial. If fed, the land has the advantage of the dung and urine of the pasturing stock; but the dung being dropped in irregular quantities, and in the heat of summer when it is devoured by insects, loses much of its utility. If the dung arising from the herbage, whether consumed in soiling or as hay, were applied to the land, in one body, and at the proper season, the operation would be more effectual. The smother of a thick crop, continued for any time upon the ground, greatly tends to promote its fertility; and it has been pretty uniformly found, after repeated trials, upon soils of almost every description, that oats, taken after clover that has been cut, either for soiling or hay, is superior to the crop taken after clover pastured by sheep."

The method of producing sward by means of planting or inoculation, is admirably adapted to all light soils, whether arenaceous, moorish, peaty, or otherwise, which do not possess a natural aptitude for grass, or freely promote the germination of artificially sown grass-seeds; for it lays upon them nuclei or little masses of full-grown, living, vigorous plants, produced upon good soil, and continuing to be rooted in portions of it, and leaves these to dispread themselves athwart intervening spaces, so as to create an aggregate sward of incomparably thicker texture and finer quality than could have been raised on such ground from seeds. The land to be inoculated must be thoroughly cleaned, pulverized, and otherwise prepared by means of a summer fallow. The season selected for the process ought to be as soon after the early autumnal rains have fallen as to moisten the sward or turf sufficiently for paring it off clean, and to wet the fallow ground sufficiently for disposing it to unite with the transplanted turf and commence the nourishing of its roots. The sward employed ought to be good, clean, sweet, fibrous-rooted turf of very rich old meadow; and it should be carefully taken up in stripes of two inches or at most three inches in breadth, and afterwards so subdivided as to be cut into small squares of the same extent as the breadth of the stripes. No more ought to be cut in one day than is likely to be planted before night. The little squares must be placed, with the grassy surface uppermost, at distances from one another of five or six inches, and pressed into the ground by means of a heavy roller. Turf from one acre of meadow ought to be quite sufficient for planting nine acres of ground. The little squares speedily unite themselves to the soil, and soon begin to make lateral growths, in the direction of filling the intermediate spaces; and at intervals, in proper states of the soil and the weather, when the little squares are in a medium condition between wet and dry, they ought to be heavily rolled, in order to make them extend themselves along the ground, and to prevent them from rising into tufts. The intervals are liable to be infested with weeds, and ought, till they become filled with sward, to be repeatedly cleaned by means of a narrow hoe; and if the turf should have been deficient in white clover or any of the most desirable grasses, the intervals, or rather the whole surface, ought to be sown with the seeds of these in the course of the next spring. The young pasture is soon sufficiently formed to lose all appearance of the intervals; but it ought not to be touched by stock during the first spring or summer, or till it has matured and shed seeds, or even till the grass in the original intervals becomes so thick and matted as to constitute quite compact turf.

The legal question of grass lands, as a question between the landlord and the tenant, has given rise to more disputes in England than any other question involved in farm-leases; and it has long and generally been in so loose a state as to present a very serious impediment, or often an insurmountable obstacle, to the practice of the convertible husbandry. "Some agreements," says Donaldson's edition of Bayldon, "enjoin one-third and others one-fourth of the farm to remain in grass, and not to be ploughed or converted into tillage without a written leave from the landlord; while in the grazing counties, one-half is prescribed, and on some poor soils, as much as two-thirds. If there be no written agreement, or if it be silent on this point, it is understood that the tenant must leave as much land in grass when he quits the farm, as he found when he entered upon it. If the tenant ploughs any grass lands during his occupation, or on quitting does not leave as much land in grass as he found on entering, he is liable by the law on that point to remunerate the landlord for the damages thereby sustained. The amount of such damages is usually ascertained by charging half rent and taxes, two dressings, an average allowance of clover seeds and hay seeds, sowing and harrowing, which may amount to between £3 and £4 an acre. Many agreements stipulate for £5 an acre, and some valuers contend for that allowance in the absence of any agreement. * * If the tenant has laid down any grass land during his tenancy, it is not taken as such, unless laid down with the proper seeds, after a fallow well cleaned and manured. On some estates, it is customary to allow for grass lands that may be laid down by the tenant in addition to the stipulated quantity, which, if it has not been mown too often, and if it has been well managed, is paid for by the rate above-mentioned. * * Leases and agreements most frequently mention the names of the fields, and the quantity of acres in each, that are to be kept in permanent grass and not to be ploughed; and, consequently, any improvements the farmer can effect must be by draining and top-dressing, if necessary. If the farmer lays down more land, the allowance per acre may be expressed, and by clear and correct definitions much cavil and dispute may be avoided." See the article LEASE.—*Sir John Sinclair's Code of Agriculture.—The Farmer's Magazine.—Reports to the Board of Agriculture.—Parliamentary Enquiries into the state of Irish Agriculture.—Bayldon's Art of Valuing Rents and Tillages.—Young.—Doyle.—Rham.—Davy.—Stephens.*

GRASS-LEASE. Either a lease of grass lands, or an appropriation of grass lands to depasturing.

GRASS OF PARNASSUS,—botanically *Parnassia.* A genus of curious and beautiful, hardy, perennial-rooted, herbaceous plants, of the sundew order. The marsh species, *Parnassia palustris,* is an elegant indigen of the bogs of Britain. Its stems are angular, twisted, and about 6 inches high; its leaves are somewhat heart-shaped, and have several longitudinal ribs, and stand on footstalks three or four times longer than themselves; and its flowers are about half an inch wide, scentless, white, and ribbed with pellucid green, and bloom in July and August.—The asarum-leaved species, *Parnassia asarifolia,* was introduced to Britain about 35 years ago from North America; and is often mentioned as one of the numerous botanical curiosities which engage the attention of naturalists. Its flower-stems are about 6 inches high; its leaves are heart-shaped, and have no footstalks, but seem to fold round the base of the stems,—and in some varieties, a single one stands quite above the rest and away from them, appearing as if it had been carried up from among them by the stem to which it adheres; and its flowers have a white basis touched with a greenish tint, and everywhere variegated with distinct green stripes, and bloom also in July and August. It may be propagated by dividing the roots, and requires a shady bed of bog-moss or moist peaty soil. Two other species, the small-flowered and the Carolinian, have been introduced from North America; and several additional species are known. The name of the genus alludes to the ancient fabulous abode of poetry and beauty; and is intended to indicate the gracefulness and elegance of the plants. Yet attractive though this genus be, the name might with far more propriety have been given to any one of hundreds of other genera.

GRASS SEEDS. See SEEDS, GRASSES, and AGRICULTURAL SEEDS.

GRASS-WALKS. Paths, plats, and divisions of grass in gardens. They are best formed by laying turfs from a clean, fine, old meadow; and when formed by sowing, they ought to be very finely pulverized and very thickly sown. They cannot be kept in prime condition without very frequent mowing and rolling; and when so neglected or abused as to become irregular in their sward, or to be spotted and blotched with pieces of dead or obliterated turf, they ought to be sown over in autumn, with special reference to their worn or bared parts, and then dressed into complete order in spring. See the article LAWN.

GRATIOLA. See HEDGE-HYSSOP.

GRATTEN. The first crop of grass after a piece of grass land has been manured with sea-sand. The mowing of the crop is called mowing in gratten. But the word is strictly provincial.

GRAUWACKE. See GREYWACKE.

GRAVEL. A mass of pebbles or small water-worn stones, from the size of a pea to that of a plum or a small potato. In this state, it occurs principally on the bed and margins of streams, and consists of quite recent disintegrations of rocks. But gravel also comprises superficial strata of ground, constituting either soil or subsoil or both, and lying at any height above sea-level, and at any distance from the present course of streams; and in this state, it consists either of diluvium, or of old, middle-aged, or recent alluvium, and when it lies at or near the surface, is generally more or less mixed with sand and with decayed organic remains. In the former state, it seldom covers any considerable tract of surface, and is never an object of interest to the farmer or the gardener, except as a material for gravel-walks and for some objects of minor economy; but in the latter state, it often constitutes extensive tracts of country, and generally possesses the character either of ground in actual cultivation, or of waste land which the agriculturist either sadly abandons to sterility or wistfully treats as a subject of reclamation.

The gravel of soils and subsoils bears a similar relation to the sand of soils and subsoils, as that which conglomerate rock bears to sandstone rock. The stones or pebbles of it may be widely different in any two of a dozen specimens, and aggregately consist of the water-worn fragments of all sorts of rocks, from sandstones and limestones up to the oldest and hardest granites, clay-schists, and quartzose rocks, which have been broken up and carried away by the slow action of water; and the pulverulent matter of it, corresponding in a degree to the cement of conglomerate, may exhibit a predominance of either arenaceous matter, calcareous matter, argillaceous matter, or vegetable mould, or may be a mixture, in any proportions, of two or three or all of these materials.

Gravelly soil possesses every gradation and variety of character from utter barrenness to comparatively high fertility. Loose kinds of it, consisting of hard round pebbles, with intermixtures only or chiefly of silicious sand, are usually the worst varieties; and if not absolutely barren, require such enormous quantities of both mineral and organic manures to render them productive, as to have occasioned them to be called hungry gravels. The principal means of reclaiming these are to intermix clay with them, and to give them, when practicable, abundant irrigation. Gravelly soils of a soft nature and somewhat firm consistency, with easily disintegrable pebbles, and an intermixture of either argillaceous, calcareous, or vegetable powdery matters, or with abundance of gritty particles of schist or limestone, are the best; and these greatly improve by tillage and exposure, and often possess a somewhat high rank among the soils of a farm. "The rich gravels," remarks Professor Low, "will produce all the cultivated kinds of grain. Their looser texture renders them less suited than the clays to the growth of wheat and beans; but they are admirably adapted to the growth of barley and oats. They are quick in their powers of producing vegetation; and, from this quality, they are in some places termed sharp or quick soils. They readily admit of alternations of herbage and tillage, and improve in a state of perennial pasturage. They are generally trusty soils with regard to the quality of the grain which they yield; and, in this respect, they differ from many of the sands, in which the quality of the grain produced does not always accord with its early promise. Gravels, like sands, are suited to the culture of the different kinds of plants raised for the bulbs and tubers of their roots; and they are in so peculiar a degree suited to the growth of turnips, that, in some parts, they receive the distinguishing appellation of turnip soils."

GRAVEL. A disease in the bladder. See the articles STONE-IN-THE-BLADDER and CALCULUS.

GRAVEL WALKS. Garden paths, made wholly or principally of gravel. Many loose kinds of gravel, particularly such as occur on the margins of rivers and the beach of estuaries and bays, are used for making walks; but they always continue loose, and afford an yielding and uneasy bed for the foot, and give frequent or almost constant occasion for the trouble of levelling and rolling. When any such gravels are used, they ought to be thoroughly mixed with from one-fourth to one-third of their own bulk of strong cohesive loam; and whenever a choice of kinds can be had, those gravels ought always to be preferred, which either have good cohesive loam in commixture with themselves, or lie in the vicinity of some place whence it can easily be obtained. White gravel, abounding in quartz or felspar, is much esteemed by many persons, and is sometimes maintained in a white state by means of a frequent rolling of the walks with rollers of hewn stone; but it strongly reflects the rays of the sun, and both dazzles the eyes, and damages the proper effect of the garden scenery. Red gravel, containing a very appreciable intermixture or adhesion of oxide of iron, is in much request by many, either by itself or with an intermixture of loam; but, though it usually settles into a very compact mass, and forms almost as smooth and uniform a surface as a piece of Arbroath pavement, yet it partially liquefies in moist weather, and acquires a marred and haggard appearance from the tread of feet, and gives off a coat of sticky paste to the soles of one's shoes. The variety most esteemed by Miller and other eminent gardeners of the last century, was that of Blackheath, in Kent; and this, when mixed with a proper proportion of loam, found on the same common, made the most beautiful and lasting walks anywhere known in the world, and so far excelled any material in France or Italy or other parts of continental Europe, that some of it was exported to adorn the papal garden at Rome. Kensington gravel has now been, for a long time, in pre-eminent repute; and in 1829, was incidentally noticed by Loudon as follows: "We have known this gravel employed in very small places in Scotland; and every body knows that it is employed in many eminent gardens in Poland and Russia, and even in India and South America. We should think a very handsome and durable walk," in places distant from Kensington, and destitute of all good native materials for garden walks, "might be formed by laying the bottom with brick rubbish, or small stones, gravel, &c., with a little lime, and then embedding a thin coat of Kensington gravel in Roman cement. Such a walk, formed with care, might be expected to last many years; no worms or weeds would rise in it; and to prevent moss from appearing, it might be watered occasionally with salt water."

Gravel for walks needs not be passed through any screen, and certainly ought not to be passed through a fine one; and it does best when merely cast into a round heap, and freed from its large stones with the rake. A gravel walk with a comparatively high curvature looks narrow to the eye, and does not afford the most pleasant surface for the feet; and no one of 5 feet in breadth needs to have a higher curvature than one inch,—and no one of 10 feet a higher curvature than two inches. Any gravel walk may be made most efficiently in March; none ought to be made in winter; and any one which cannot be kept free from moss and weeds by the simple expedient of rolling it after frost and after rains, ought to be re-formed, or turned over and laid down again, in March. The basis of every gravel walk, especially upon till, clay, or any other kind of wet subsoil, ought to be laid deep with stones, flints, broken bricks, or any sort of hard porous rubbish; or if none of these can be readily obtained, it ought to be formed upon a bed of cut heath or furze; and the gravel mixture itself, except in extraordinary circumstances, ought to form a stratum of 8 or at least 6 inches in depth; and the general inclination of the surface ought to have such a slope to the lowest part of the ground, or to proper sink-stones at intervals by the sides of the walks, as to occasion the speedy and complete discharge of all surface-water.

GRAVITY, in physics. The natural tendency or inclination of bodies towards a centre.

Terrestrial gravity is that force by which all bodies are continually urged towards the centre of the earth. It is in consequence of this force, that bodies are accelerated in their fall, and, when at rest, that they press the body, or that part of the body, by which they are supported. As to the cause of gravity, or its nature, nothing is known; and it would be useless to detail the hypotheses advanced to account for this most important law of nature. All that can be said is, that it appears to be an essential property of matter, or, at least, of all matter that has hitherto become the object of human investigation, though it is by no means certain that matter may not exist, which is not subject to its influence. This part of the subject appears to be beyond human comprehension. Instead, therefore, of wasting our time in useless speculation as to the cause, let us only attend to its effects, and content ourselves with examining more particularly the manner in which this principle operates on material bodies, and the laws by which it appears to be regulated; the principal of which, as deduced from experiment, or from the most unequivocal inferences, are as follows: 1. That gravitation takes place between the most minute particles of bodies; 2. that it is proportional to the masses of those bodies; 3. that it varies inversely as the square of the distance, in proceeding from the surface of the body outwards, or from its centre; 4. that it varies directly as the distance, in descending from the surface to the centre in uniform spherical bodies; 5. that it acts equally on bodies in a state of rest, as on those in motion, and that its action in the latter case is always the same, whether that motion be to or from the centre of attraction, or in any other direction; 6. that it is transmitted instantaneously from one body to another.

The dependance of all animal motions upon the attractive force of the earth is sufficiently obvious. Each animal body is acted upon by gravity, in proportion to its mass; in other words, it possesses weight; and in order that animals may exercise the power of moving, it is necessary that their forces shall bear a certain relation in excess to that of gravity, otherwise no motion could follow. Their forces must also be proportioned to the resistance which gravity offers to their exertions, or else animals would lose their balance, their motions would proceed by jerks; at one time they would endanger their own safety by an excessive rapidity, at another by an excessive slowness; in all they would be devoid of grace, energy, and convenience. Animals would come into collision with other animals, or with harder substances than their own bodies; and this globe of earth, like a machine out of order, would soon lie in a state of inactivity and disorganization. Mr. Whewell remarks, that if the force of gravity were increased in any considerable proportion at the surface of the earth, all the swiftness, and strength, and grace of animal motions must disappear. If, for instance, the earth were as large as Jupiter, gravity would be eleven times what it is; the lightness of the fawn, the speed of the hare, the spring of the tiger, could not exist with the existing muscular powers of those animals; for man to lift himself upright, or to crawl from place to place, would be a labour slower and more painful than the motion of the sloth. The density and pressure of the air, too, would be increased to an intolerable extent, and the operation of respiration and others which depend upon these mechanical properties, would be rendered laborious, ineffectual, and probably impossible. If, on the other hand, the force of gravity were much lessened, inconveniences of an opposite kind would occur. The air would be too thin to breathe; the weight of our bodies, and of all the substances surrounding us, would become too slight to resist the perpetually-occurring causes of derangement and unsteadiness; we should feel a want of ballast in all our movements. Things would not be where we placed them, but would slide away with the slightest push. We should have a difficulty in standing or walking, something like what we have on ship-board when the deck is inclined; and we should stagger helplessly through an atmosphere thinner than that which oppresses the respiration of the traveller on the tops of the highest mountains. The force of gravity depends upon the mass or quantity of matter in the earth. For any reason that we can discover, this globe might have been as large as Saturn or Jupiter, its mean density might have been that of cork or of gold, in any of which cases the force of gravity would have been very different from what it is at present; and we can easily imagine, that if every thing were seven times as heavy, or one-seventh lighter than it actually is, animals could not exist in their present state. The moon and planets all differ in size and density from the earth, and from each other; and in general, the smaller seem to be nearest to the sun, for our imperfect gaze fails to discover the lesser bodies which probably exist in the outward regions of the solar system. For this reason, the inhabitants of other globes must be so different from ours, as to render it almost impossible for us to form any conception of their nature.

Thus the earth is not only the common source whence animals and plants derive their subsistence, but it is the common source of all animal motions, not only in the reaction offered by its inertia, but in the looseness of that invisible tie which connects our bodies to its surface. Our relations to the earth are not even confined to the surface, but extend to those remote depths which the miner and geologist contemplate only in imagination; and every particle of matter towards the centre exercises an influence in proportion to its magnitude. The intimate relation of the earth to the inhabitants of its surface, has led all ages to regard it as the common mother of all; and nations have been proud to consider themselves *autochthones*, or sprung from "the dust of the earth,"—their native soil.

Gravity, as relating to the science of mechanics, is divided into *absolute* and *relative*. *Absolute gravity* is that by which a body descends freely and perpendicularly in a vacuum or non-resisting medium. *Relative gravity* is that by which a body descends, when the absolute gravity is constantly counteracted by a uniform, but inferior force, such as in the descent of bodies down inclined planes, or in resisting mediums.

Specific gravity is the relative gravity of any body or substance, considered with regard to some other body, which is assumed as a standard of comparison; and this standard, by universal consent and practice, is rain water, on account of its being less subject to variation in different circumstances of time, place, &c., than any other body, whether solid or fluid; and, by a very fortunate coincidence, at least to English philosophers, it happens, that a cubic foot of rain water weighs 1000 ounces avoirdupois. Consequently, assuming this as the specific gravity of rain water, and comparing all other bodies with this, the same numbers that express the specific gravity of bodies, will at the same time denote the weight of a cubic foot of each in avoirdupois ounces, which is a great convenience in numerical computations. From the preceding definition, we readily draw the following laws of the specific gravity of bodies; viz. 1. In bodies of equal magnitude, the specific gravities are directly as the weights, or as their densities; 2. in bodies of the same specific gravities, the weights will be as the magnitudes; 3. in bodies of equal weights, the specific gravities are inversely as the magnitudes; 4. the weights of different bodies are to each other in the compound ratio of their magnitudes and specific gravities. Hence, it is obvious, that, of the magnitude, weight and specific gravity of a body, any two being given, the third may be found; and we may thus find the magnitude of bodies, which are too irregular to admit of the application of the common rules of mensuration; or we may, by knowing the specific gravity and magnitude, find the weight of bodies which are too ponderous to be submitted to the action of the balance or steelyard; or, lastly, the magnitude and weight being given, we may ascertain their specific gravities.

Other properties relating to the specific gravity of bodies are as follows; viz. 1. A body immersed in a fluid will sink, if its specific gravity be greater than that of the fluid; if it be less, the body will rise to the top, and be only partly immerged; and if the specific gravity of the solid and fluid be equal, it will remain at rest in any part of the fluid in which it may be placed. 2. When a body is heavier than a fluid, it loses as much of its weight, when immersed, as is equal to a quantity of the fluid of the same bulk or magnitude. 3. If the specific gravity of the fluid be greater than that of the body, then the quantity of the fluid displaced by the part immerged, is equal to the weight of the whole body; and hence, as the specific gravity of the fluid is to that of the body, so is the whole magnitude of the body to the part immerged. 4. The specific gravities of equal solids, are as their parts immerged in the same fluid. 5. The specific gravities of fluids are as the weights lost by the same immerged solid. A solid substance, rarer than the fluid medium, must evidently sink, till it displace an equal weight of the fluid. The submerged part of the solid hence always marks the volume of this equiponderant mass. If the floating body have a globular shape, terminated by a long slender stem, its depression in any liquid will measure the smallest differences of specific gravity. The stem may be made exactly cylindrical, for instance, and divided into portions which correspond to the 1,000th parts of the bulk of the ball. Such is the general construction of the hydrometer, a very convenient instrument for examining readily the densities of different liquids. The stem will scarcely bear more than 100 distinct subdivisions; but the range can be easily enlarged, by attaching, as circumstances may require, loads answering to 100, 200, 300, &c. One of the easiest and simplest methods of determining the densities of different liquids, is by a set of small glass beads, previously adjusted, and numerically marked. Thrown into any liquor, the heavier balls sink, till they approach the required density, and become gradually buoyant, and the one which first rises to the surface indicates, in 1,000th parts, the specific gravity of the fluid. These balls are adapted for examining liquids, whether lighter or heavier than water. But the most accurate and concise mode of ascertaining the density of liquids, is to employ a small glass measure with a very short, narrow neck, and adjusted to hold exactly 1,000 grains of distilled water. The vessel being filled with any other liquid, the weight of it is observed, and thence its relative density to water may be found by merely striking off three decimal places. At each operation, the glass must be carefully rinsed with pure water, and again dried, by heating it, and then sucking out the humified air, for a few minutes, by the help of a slender inserted tube. If fluids of various densities, and not disposed to unite in any chemical affinity, be poured into a vessel, they will arrange themselves in horizontal strata, according to their respective densities, the heavier always occupying a lower place. This stratified arrangement of the several fluids will succeed, even though a mutual attraction should subsist, provided its operation be feeble and slow. Thus a body of quicksilver may occupy the bottom of a glass vessel, above it a layer of concentrated sulphuric acid, next this a layer of pure water, and then another layer of alcohol. The sulphuric acid would scarcely act at all upon the mercury, and a considerable time would elapse before the water sensibly penetrated the acid, or the alcohol the water. Bodies of different densities might remain suspended in those strata. Thus, while a ball of platinum would lie at the bottom of the quicksilver, an iron ball would float on its surface; but a ball of brick would be lifted up to the acid, and a ball of beech would swim in the water, and another of cork might rest on the top of the alcohol.

TABLE OF SPECIFIC GRAVITIES OF METALS, STONES, EARTHS, &C.

Metals.	
Platinum purified,	19.50
" hammered,	20.34
" laminated,	20.34
" drawn into wire,	22.07
Gold, pure and cast,	19.26
" hammered,	19.36
Mercury,	13.57
Lead, cast,	11.35
Silver, pure and cast,	10.47
" hammered,	10.51
Bismuth, cast,	9.82
Copper, cast,	8.79
" wire,	8.89
Brass, cast,	8.40
" wire,	8.54
Cobalt and nickel, cast,	7.81
Iron, cast,	7.21
Iron, malleable,	7.79
Steel, soft,	7.83
" hammered,	7.84
Tin, cast,	7.30
Zinc, cast,	7.20
Antimony, cast,	4 95
Molybdenum,	4.74
Sulphate of barytes,	4.43
Zircon of Ceylon,	4.41
Stones.	
Oriental ruby,	4.28
Brazilian ruby,	3.53
Bohemian garnet,	4.19
Oriental topaz,	4.01
Diamond,	3.50
Crude manganese,	3.53
Flint glass,	2.89
Glass of St. Gobin,	2.49
Fluor spar,	3.18
Parian marble,	2.34
Peruvian emerald,	2.78
Jasper,	2.70
Earths, &c.	
Carbonate of lime,	2.71
Rock crystal,	2.65
Flint,	2.59
Sulphate of lime,	2.32
Sulphate of soda,	2.20
Common salt,	2 13
Native sulphur,	2 03
Nitre,	2.00
Alabaster,	1.87
Phosphorus,	1.77

Plumbago,	1.86
Alum,	1.72
Asphaltum,	1.40
Jet,	1.24
Coal, from	1.24 to 1.30
Sulphuric acid.	1.84
Nitric acid,	1.22
Muriatic acid,	1.19
Liquids, Oils, &c.	
Equal parts by weight of water and alcohol,	.93
Ice,	.92
Strong alcohol,	.82
Sulphuric ether,	.74
Naphtha,	.71
Sea water,	1.03
Oil of sassafras,	1.09
Linseed oil,	.94
Olive oil,	.91
White Sugar,	1.61
Resins, Gums, &c.	
Gum arabic and honey,	1.45
Pitch,	1.15
Isinglass,	1.11
Yellow amber,	1.08
Hen's egg, fresh laid,	1.09
Human blood,	1.05
Camphor,	.99
White Wax,	.97
Tallow,	.94
Pearl,	2.75
Sheep's bone,	2.22
Ivory,	1.92
Ox's horn,	1.84
Wood.	
Lignum vitæ,	1.33
Ebony,	1.18
Mahogany,	1.06
Dry oak,	.93
Beech,	.85
Ash,	.84
Elm, from	.80 to .60
Fir, from	.57 to .50
Poplar,	.38
Cork,	.24
Gases.	
Chlorine,	.00302
Carbonic acid gas,	.00164
Oxygen gas,	.00134
Atmospheric air,	.00121
Azote,	.00098
Hydrogen gas,	.00008

GRAVITY (Centre of). In mechanics, a point within a body, through which, if a plane pass, the segments on each side will equiponderate; that is, neither of them can move the other. Hence, if the descent of the centre of gravity be prevented, or if the body be suspended by its centre of gravity, it will continue at rest in equilibrium in any position. The whole gravity, or matter, of a body may be conceived united in its centre of gravity; and, therefore, it is usual, in demonstration, to substitute the centre for the body. In homogeneous bodies, which may be divided lengthwise into similar and equal parts, the centre of gravity will be the same as the centre of magnitude. The centre of gravity of a parallelogram or cylinder, or any prism whatever, is in the middle point of the axis, and the centre of gravity of a circle, or any regular figure, is the same as the centre of magnitude. The common centre of gravity of two bodies, is a point so situated in a right line joining the centres of the two bodies, that, if the point be suspended, the two bodies will equiponderate and rest. Thus the point of suspension in a balance or steelyard, where the two weights equiponderate, is the common centre of gravity of the two weights.

GRAYLING,—scientifically *Salmo Thymallus.* An elegant British fish, of the salmon tribe. Its body is smaller than that of the trout; its head is small and dusky; its eyes are protuberant, and have silvery irides, speckled with yellow; its upper jaw is larger than the under jaw; its teeth are seated in the jaws and roof of the mouth, and are very minute, and feel like a fine file; its gills are blackish when the fish is in perfection, and glossy green at other seasons; its back is dusky green, inclining to blue; its sides are fine silvery grey, and give occasion to the popular name of grayling; and yet, when the fish is first taken from the water, they seem to glitter with spangles of gold. The whole fish rarely exceeds 16 inches in length; the side-line is nearly straight; the scales are large, with dusky lower edges, and form straight rows from the head to the tail; the dorsal fin is large and spotted; the other fins are plain; and the tail is much forked. The fish is rather hog-backed, touches the ground with nose and belly at once, and is supposed to feed mostly at the bottom. It has been imagined to emit a fragrance similar to that of thyme; and it takes from that circumstance its specific name thymallus. The grayling frequents clear and rapid streams; and occurs in those of Derbyshire, Shropshire, Yorkshire, and some other districts. It is in season from September till January, but has white and palatable flesh at all times of the year; and it requires to be dressed as speedily as possible after being caught. It lies close during winter, and starts into activity and spawns in April or the early part of May.

GRAZIER. A farmer who employs himself principally in buying, feeding, and selling cattle and sheep. He differs from a stock-farmer and a store-farmer, in paying little or no attention to the breeding or the rearing of stock,—in having a closer connexion and far more frequent interchange with the markets for stock,—in devoting his chief professional skill to the speediest and most profitable fattening of the particular breeds and individuals which he judges to have the best adaptation jointly to his pastures and to the markets,—and in occupying, not remote, upland, and generally poor pastures among the mountains, but rich grass lands, old meadows, and other varieties of fattening pastures amid populous and town-environed plains. He requires a good knowledge of the many different breeds of stock, an intimate acquaintance with the peculiar adaptations or non-adaptations of each breed to such circumstances of climate and pasture as those which characterize his farm, a ready discernment of the excellencies or defects of any individual of each breed, a profound knowledge of the many principles and practices involved in the most economical treatment of grass lands, and thoroughly mercantile habits in selecting the best markets, in making the most seasonable purchases and sales, and in subordinating his whole professional conduct to the fluctuations and even the caprices of demand. The stocking of almost any farm, but especially the continuous stocking of one which is mainly employed as middle-ground between the breeders of lean stock and the consumers of fattened stock, requires a larger concentration of skill and tact than almost any other single department of agricultural effort; and the proper management of grass lands, especially if they happen to be varied in soil and in the character of their vegetation, demands a degree of scientific knowledge, of discernment, and of reflexion second only to those which are needed for the proper treatment of arable land. Grazing, even when wisely conducted, is profitable only upon extensive pastures, and in districts where the value of animal food is so high as to make it equal or excel grain as a marketable agricultural produce; and it is practised most extensively in the midland counties of England, and especially in Leicestershire and Lincolnshire.

Some of the most intelligent graziers classify their pastures, whether in fields, or by temporary subdivisions, into four sets,—one, held in complete reserve, till its grass have attained full growth, or be in the best condition for the final fattening of stock,—another, used by fattening animals immediately preparatory or antecedent to their being admitted into the reserved set,—another, used by the lowest or most backward group of the fattening stock,—and the fourth, used first by the working or store portion of the stock, and next by lean sheep, to eat the pasture down close to the surface. A refinement upon this plan subdivides the first set into two parts, and might subdivide the second set also into two parts, and does not allow the one subdivision to be entered till the other subdivision is grazed; and this refinement improves the aim of the whole plan, to keep the animals as amply as possible on grass which is at once luxuriant, clean and sweet. All cattle relish good grass, and consequently fatten upon it, in nearly the proportion of its freshness; and most, perhaps all, disrelish it or loathe it, and cease to derive due advantage from it, in the exact proportion in which it has been bruised with the feet, and polluted with the breath, and filthified with droppings of urine and dung. An excellent plan even on farms of the mixed or convertible husbandry, therefore, is to arrange the whole pasture-land of a farm into so many fields or subdivisions or sets that all may be occupied by the whole stock of cattle in succession, and each eaten out by them in the course of at least 14 or 16 days; and a requisite supplementary plan on such farms, would be to let the sheep either follow or accompany the cattle, in piece after piece, so that they might cut down what the high and rough feeding habit of cattle could not reach.

But grazing is practised also on hill pastures, or with the aid of hay-meadows, or even with the aid of all such appliances as are common in farms of the mixed husbandry; and in order to be nearly as profitable in any of these cases, as upon farms of old, rich, valley grass lands, it requires only to comprehend a studied adaptation of the breed and habits of the animals to the circumstances in which they are fattened. "A man who has fertile meadow or rich marsh," says the author of the Treatise on British Husbandry, "may fatten bullocks as large as he can find them; while on poor land, affording but scanty pasture, and a short bite in the summer, no bullocks will pay better than the small Galloways, or most of the Highland stock; but on richer pasture and better turnip soils, the most profitable will be found to be the larger species of the Fifeshire and Lowland Scotch, with the Hereford and short-horned Yorkshire breeds, or those grown in the neighbourhood. Graziers, however, would act prudently in ascertaining the nature of the land upon which the cattle were bred, and choosing their purchased stock from an inferior soil; for if young cattle be taken from a good to a worse soil, they are apt to become stunted in their growth, and if old enough to be fed for the butcher, they will not feed so kindly as those taken from more indifferent pasture. Generally speaking, however, bullocks from 40 to 60 stones weight, 14 lbs. to the stone, are much more saleable than larger ones, and may always be finished with turnips, and perhaps a small addition of oil-cake, if put up, as they always should be, in good condition; for nothing is more injudicious than to attempt the stall-feeding of oxen in the view of their becoming fat, at any fair expense, unless they be in good order as stores." See the articles Farm, Cattle, Grass Lands, and Pasture.

GREASE. A local inflammation in the heels of horses. It sometimes arises out of the disease called swelled legs, and has frequently been confounded with it, yet is quite distinct from that disease. See the article Swelled Legs. It occurs sometimes in the fore-feet, but oftener in the hind-feet; and, though neither contagious nor epizootic, it not infrequently appears, about one time or within a brief period, upon most or all of the horses of a stable. It essentially consists in a stoppage of the greasy secretion, which is beneficially provided for maintaining a soft condition of the skin of the heel, and preventing chapping and excoriation; and it usually develops itself in redness, dryness, and scurfiness of the skin; but, in bad or prolonged cases, it is accompanied with deep cracks, an ichorous discharge, considerable lameness, and even great ulceration and much fungous growth; and in the worst cases, it spreads athwart all the heel, extends on the fetlock, ascends the leg, and is accompanied with extensive swelling and a general oozing discharge.

Most of the causes of grease are referable to bad management, especially in regard to great and sudden changes in the exterior temperature of the heels. The feet of the horse may be alternately heated by the straw of his litter in the stable, and cooled by the opening of the stable-door; or they may be first made hot and sensitive by the irritating action of the urine and filth on the stable-floor, and then violently reacted on by the cold breezes of the open air; or they may be moist and reeking when he is led out to work, and then chilled for a long period by the slow evaporation of the moisture from them amid the clods and soil of the field; or they may be warm or even perspiring with the labour of the day, and next plunged into a stream or sponged with cold water, and then allowed to dry partly in the open air and partly in the stable; and in any of these ways, or of any others which occasion sudden changes of temperature in the heels, especially when these changes are accompanied or aggravated by the irritating action of filth, grease is exceedingly liable to be induced. Want of exercise, high feeding, and whatever tends to accumulate or to stagnate the greasy secretion in the skin of the heels, also operate, in some degree, as causes. But, by mere good management, the British cavalry have expelled grease from the list of their horses' diseases; and by the same means all yeomen and farmers might drive grease from the list of theirs.

In the early, dry, scurfy stage of grease, the heels may be well cleaned with soap and water, and afterwards thoroughly dried, and then treated with either a saturnine wash or with a saturnine ointment. In the mildest form of the stage of cracks and ichorous discharge, some drying powder, such as equal quantities of white lead and tutty, may be applied, or simply the saturnine ointment may be continued. In the virulent form of cracks, accompanied with ulceration, the heels ought to be daily washed clean with warm water, and afterwards bathed with a mild astringent lotion, and every morning and evening thinly poulticed or coated with a mild saturnine ointment, and the whole system ought to be acted on by a moderate bleeding, by alteratives, by a nightly bran mash, and, if the animal be in full condition, with one or two doses of some purgative medicine. In the worst and most extensively spread cases, poultices of a very cooling kind, particularly poultices of scraped carrots or scraped turnips, ought to be used day and night, both for the sake of their own action, and as preparatives to the action of the astringent application; and the whole course of treatment ought to aim at the abatement of the inflammation, previous to the stopping of the discharge. In the event of great obstinacy, as well as much virulence, of the disease, the horse, especially if he be young and vigorous, may require to be turned to grass. "Nothing tends so much to prevent grease and swelling of the legs," says White, "as frequent hand-rubbing, and cleaning the heels carefully, as soon as a horse comes in from exercise. In inveterate cases of grease, where the disease appears to have become habitual in some degree, a run at grass is the only remedy. If a dry paddock can be procured, where a horse can be sheltered in bad weather, and fed with hay and corn, it will be found extremely convenient; as, in such circumstances, he may perform his usual labour, and at the same time be kept free from the complaint."

GREASE. Any unctuous or oleaginous substance, whether simple or compound, such as lard, tallow, rape oil, or any mixture of fats or oils, for mitigating friction in the action of machinery. It requires to be adapted in its nature to the particular kind and circumstances of the machinery to which it is applied; and is necessarily very diversified in its own character and in the manner of its use. M. D'Arcet recommends that any ordinary grease for cart or carriage wheels, or for any machinery of similar structure, should be thoroughly combined with one-fourth of its own weight of very finely pulverized plumbago.

GREASE (MOLTEN). See DYSENTERY.

GREAT BURNET,—botanically *Sanguisorba.* A genus of hardy, ornamental, perennial-rooted, herbaceous plants, constituting the type of the suborder Sanguisorbeæ,—a subdivision of the rosaceous order. This subdivision comprises seven genera of the plants of our fields and gardens,—the most conspicuous of which are poterium, sanguisorba, and alchemilla. The genus sanguisorba comprises seven species,—all about 4 feet high, and blooming in the latter part of summer and early part of autumn, and two having white flowers, and most of the others pink-coloured flowers.

The officinal great burnet, *Sanguisorba officinalis,* grows wild in moist meadows and pastures in various parts of Great Britain. Its stem branches toward the top; its leaves are pinnate, and consist each of 5 or 6 pairs of leaflets and a terminating odd one; its leaflets are about two inches long, thin, serrated, and a little downy below; and its flowers are produced in thick oval spikes, and have a pink colour, and bloom from June till August. This plant is regarded by some persons as worthy of agricultural cultivation. A permanent variety of it is known as the eared great burnet, *S. o. auriculata.*

GREAT MACAW TREE. A palm of naturally 40 or 50 feet in height, a native of the West Indies, introduced upwards of a century ago to British palm-houses, and called formerly *Cocos fusiformis,* but now *Acrocomia fusiformis.*

GREAT TIT. See Tit.

GREEK VALERIAN,—botanically *Polemonium.* A genus of ornamental herbaceous plants, constituting the type of the natural order Polemoniaceæ. All the plants of this order are herbaceous; many have pinnate leaves; and most have beautiful or imposing flowers, principally of red, blue, and white colours. The greater number are natives of the cool parts of Europe and North America. About 70 species occur in the gardens of Britain; and all these, excepting 6 or 7, are hardy. The order comprises the nine genera polemonium, phlox, collomia, gilia, ipomopsis, pyxidanthera, caldasia, diapensia, and hoitzia. The genus polemonium comprises one indigenous species, 6 or 7 introduced exotic species, and 7 or 8 known unintroduced exotic species.

The indigenous species, *Polemonium cæruleum,* is exceedingly common in gardens, and serves as a sufficient specimen of the whole. It grows wild in some thickets; but includes two permanent varieties, the white-flowered and the spotted-flowered, which occur only in gardens. Its stems are hollow, channelled, and usually from 18 to 24 inches high; its lower leaves are pinnate, and consist each of 11 or 12 pairs of alternate and sessile leaflets and a terminating odd one, and unitedly form a somewhat dense mass of herbage round the base of the stems; its upper leaves have the same shape as the lower ones, and constitute a sort of garnishing of the stem; and its flowers are sessile, monopetalous, and beautifully blue, and grow in bunches at the summit of the stems, and usually bloom in June. This plant is a very short-lived perennial, and does best to be propagated from seeds; but it is easily raised, and requires scarcely any culture. Cats are very fond of its fragrance, and sometimes roll themselves on it, to the destruction both of its own beauty, and the neatness of the adjacent parts of the parterre.

GREEN CHEESE. Cheese stained by means of an infusion of sage leaves, parsley, or other green vegetable substances, in the milk of which the cheese is made. The practice of staining cheese green prevails chiefly in Wiltshire. See the article Cheese.

GREEN CROPS. Crops which alternate with the cereal grasses in regular rotations, or which admit of the cleansing and ameliorating cultivation called the green fallow. See the article Fallow. The principal green crops at present in use are turnips, cabbages, borecoles, beans, carrots, beet, mangel-wurzel, sainfoin, lucern, tares, and clover; but several others, well adapted to field culture, and very valuable for their economical uses, might be added. The proper treatment of green crops, in their collective relations to the soil and to the cereal members of a rotation, is noticed in the article Fallow; and the proper treatment of them in their individual character and for their distinctive uses, is noticed in the several articles on the plants themselves, such as Turnip, Cabbage, &c.—The word green crops is sometimes employed, in a large sense, to designate all cultivated esculent plants which are used in a green or unripe state; and in this sense, green crops comprise the greater portion of the ordinary productions of the kitchen garden.

GREEN DRAGON. A hardy, perennial-rooted, green-flowered species of arum,—*Arum Dracontium.*

GREENFINCH,—scientifically *Coccothraustes Chloris.* A common, pretty, little, British bird, of the finch family. It occurs in most parts of Europe, and remains in Britain throughout the year. It frequents gardens, orchards, shrubberies, groves, parks, and cultivated fields; and sometimes seeks new haunts, in severe weather, for the sake of obtaining improved shelter; and it commonly feeds on small seeds in cropped grounds in summer, on stubbles in autumn, and in stack-yards in the severe parts of winter. Its total length is about 6 or 6½ inches; its body has a prevailing tint of olive green; and its wings and tail have a black ground colour, variegated with gamboge yellow. Its nest is built sometimes in trees, but generally in hedges or low bushes; and its eggs are from four to six in number, and have a white colour, tinged with blue over the circumference, and spotted with dark brown and purplish grey at the larger end.

GREEN FALLOW. See Fallow.

GREEN FLY. Any of the green-coloured species of aphides which infest peach-trees, plum-trees, cherry-trees, or the shrubby plants of the greenhouse or the conservatory. See the article Aphis.

GREEN FOOD. Cut or gathered esculent plants, used in their fresh or succulent state. It differs from fodder in excluding all dried substances, and from pasturage or herbage in being consumed in the house. See the article Soiling.

GREENHOUSE. A glazed building for the protection of plants which are too tender to bear the effects of cold weather in the open air, and not tender enough to require the great heat and continual protection of the stove-house. It may be kept constantly open during most of the days and many of the nights of summer; and must have its sashes opened often enough, even in winter, to maintain comparative purity in its atmospheric air. It may also have most of its winter occupants removed to the open ground during summer and the early part of autumn; and may then be replenished partly with the least tender beauties of the stove-house, and partly with balsams, cockscombs, and other very tender and showy annuals. But by means of flues for the raising or maintaining of artificial heat as often or as long as may be requisite, it must both be freed from dampness of air during summer, and have constantly or generally a temperature of about 45° during winter. Its sashes must be so constructed as to produce a ready, an equable, and a protected ventilation; and its flues must be so placed and conducted as to diffuse an equal and a steady heat. Every dissipation of damp by artificial heat in warm weather ought to be accompanied with free and abundant ventilation; the maintenance of artificial temperature during frosty weather, ought never to exceed 45°, and may be a little lower; the appearance of aphides, in any considerable numbers, ought to be promptly checked and destroyed by a fumigation; and the appearance of minute fungi or "moulds" on any of the leaves of any of the plants, ought always to be arrested by the instant and careful removal of the infected leaves. The floor, the pots, and the stages ought to be maintained in a thoroughly clean condition; the plants ought to be duly and regularly watered, and to receive all the routine culture required by their respective habits, and to be kept in a neat and tasteful order; and all the interior, in all its parts and contents, ought to be free from every mark of labour, and to exhibit the repose, the dignity, and the imposing and exhilarating powers appropriate to the chief and cherished retreat of the flower-garden.

The greenhouses of a former age had slated roofs and large upright windows,—the latter divided and upheld by pillars; but these structures or any others with opaque roofs are suitable chiefly for orange-trees, lemon-trees, and other large and shade-loving plants, and are utterly unfit for any plants which require much of the chemical action of light,—and therefore utterly unfit for the vast majority of proper greenhouse plants; and almost all of them which continue to be used are now considered to be, not greenhouses in any ordinary sense of the word, but orangeries. Other greenhouses of a former period, and many old greenhouses of the present day, have their front and their back entirely of masonry or of brickwork, and are glazed only on the top and at the ends; and these possess a medium adaptation between the opaque-roofed structures and the true greenhouses, and do best to be employed as conservatories, or for large plants growing in beds of earth sunk in the floor, either bold-growing tall shrubs and small trees, or lofty and far-spreading ornamental climbers, such as *Passiflora kermesina*, *Ipomœa coccinea*, and *Dolichos lignosus*, which can be trained along the rafters.

The best greenhouses at present in use are constructed with span-roofs; and are glazed, not only above and at the ends, but along the upper part of the sides. The roofs of some have a domical outline; and those of many of the newest have their rafters of kyanised wood, or bars instead of rafters, and formed of iron, or of zinc. The most old-fashioned of the prevailing form of the walls is "a lean-to,"—all wall in the back, and a very low wall in the front; a newer prevailing form has a back-wall of about two-thirds of the height of the roof, and a front and end walls of about 3 or 4 feet in height; and the newest prevailing form has a low wall all round, and has the two sides, as well as the two ends, uniform with each other, and displays, in all its proper proportions, the true or regular span-roof. But the front wall in the second of these forms, and both of the side walls in the third, are surmounted by a row of upright sashes, of about 18 or 20 inches in height; so that the lower edge of the roof, or sloping series of sashes, is situated at a height of 4½ feet or upwards from the surface of the ground. The internal arrangement corresponds, in some degree, to the external form, and may consist of one front bench and one gradation of stages, or of benches on each side and a doubly graduated stage, or may be otherwise fitted up either in compliance with mere taste or in precise adaptation to the special selection of plants which are intended to be cultivated in it; but, in every instance, it must have its bench or benches and the successive shelves of its stage or stages fixed at such distances from the roof as will produce a magnificent *tout ensemble* in the grouping of the plants, and as will place the summits of all sufficiently near the roof to let them enjoy the full and direct rays of the sun. Many greenhouses, even among those of the newest construction, have an exceedingly plain appearance; and yet all, with scarcely any appreciable injury to their light or their adaptations, might, with very little additional expense, be made decidedly ornamental.

The length and breadth of a greenhouse may be endlessly varied, yet, for the sake of appearance, ought to be mutually proportionate. The height of such as stand in juxtaposition with mansions, ought not to be less than that of the loftiest apartment with which they communicate; and that of detached ones may vary from 9 to 24 feet, according to their size. "If the greenhouse is long and too narrow," says Miller, who often wrote in such a way as if his writings were never to become old, "it will have a bad appearance both within and without; nor will it contain so many plants, if proper room be allowed for passing in front and on the backside of the stands on which the plants are placed;—and on the other hand, if the depth of the greenhouse is more than 24 feet, there must be more rows of plants placed to fill the house than can with conveniency be reached in watering and cleaning; nor are houses of too great depth so proper for keeping plants as those of moderate size." The best possible combination of form and position in a greenhouse is an equal-sided or regular span-roofed one standing east and west, with the door-end facing the south; so as to take in the full play of both forenoon and afternoon sun, and as to have no opening to the chilly north;—and the worst possible combination of form and position is a lean-to facing otherwise than southerly, or a lean-to with a southerly facing but upon northerly sloping ground, or whatever shall give the shelves of the stage a northern exposure, and exclude the soft and genial zephyr, and invite the keen and foggy east wind. But very many good or even excellent combinations, intermediate between these extremes, may be chosen to suit the peculiarities of situation, as to either the slope of the ground or the grouping of adjacent structures.

GREENHOUSE-BUG,—scientifically *Coccus Hesperidum*. A heteropterous insect of the gallinsecta or coccidæ family. See the article Coccus. The male of the greenhouse-bug is very small, and has two wings; and the female is larger and without wings, and when young she runs upon the stems of myrtles, orange-trees, and other greenhouse and orangery plants, and afterwards settles down upon a piece of spray, or upon a leaf, or upon the rind of a fruit, attaches herself as firmly to it as a limpet to the rock, and deposits upon it hundreds or thousands of her eggs, and dies. The application of a weak mixture of white arsenic in thin mucilage or gum-water, has often been recommended for killing the bug; but, even when cautiously applied, it is very liable to kill also the leaves and even the stems and roots of the orange-plant. A safe and efficacious appliance is to wash the infested part of the plants with weak hartshorn.

GREEN MANURE. Vegetable substances incorporated with the soil in their succulent state, to act as fertilizers for subsequent crops. They may be either entire plants or parts of plants; either weeds, or part of cultivated crops, or the whole of cultivated crops; either the produce of waste grounds carried to arable fields, or the refuse of any kind of useful produce, or specially raised upon the spot with the express design of being used as manure; either used some little time after becoming dead, but before losing their succulency, or buried in the soil by the same act or process which destroys their life.

Vegetables returned, partly or wholly, into the soil in the same condition in which they have grown out of it might seem, to an unreflecting person, or to one unacquainted with agricultural chemistry, utterly incapable of acting as fertilizers; and certainly, if they derived all their substance out of the soil, and were to return it in the same state of chemical combination and with the same play of chemical affinities in which they derived it, they would give back exactly what they received, and affect the soil none otherwise than by the accessories and accidents of their culture. But by far the largest portion of their bulk is derived, not from the soil at all, but from air and water,—and the whole of this is contributed by green manure as clear gain to the soil, or as prepared and ready aliment for the succeeding crop; and the remainder of their bulk, though extracted from the soil, is brought into new affinities, and more practicable ones than before,—so that even this, as returned to the soil by green manure, is in a condition for more rapid and advantageous assimilation than if it had not recently played a part in vegetable growth.

"It will be readily granted," says Mr. Shier, "that the amount of produce that can, in any shape, be exported from a farm, without deteriorating the land, is a portion corresponding to what the crops have drawn from the air, above what was contained by the manure. Inorganic substances are derived exclusively from the soil; but as crops contain a certain proportion of these, the supply must be maintained either by decomposition of mineral matter in the soil—and even in the best soils this is but a limited source—or by manures obtained from sources foreign to the farm. It follows then that, if plants capable of drawing largely on the air are grown, and ploughed in at the time they contain most of the matter so derived, and in a condition favourable to steady and complete decay, that all that could be exported is gain, and is laid up in the soil, to enable it to minister to other crops of more profitable kinds. The plants which form the most valuable food for animals are almost all incapable of being raised on very poor soils, and they draw most largely on the soil for support; there are, however, others less fitted for feeding animals, that draw largely on the air, and are capable of growing on poor soils; it is these that are most appropriately employed for green manuring. In selecting plants for this purpose, care should be taken that they are rapid growers, nourished chiefly at the expense of the air, capable of autumnal growth, and that they are hardy and suitable to the soil and the climate. Green plants are greatly superior to dry ones as manure, in being capable of speedier and more complete decomposition. Dry vegetable matter introduced into the soil decomposes slowly, because, in drying, changes have already taken place in the sap that render it less prone to decomposition even in the presence of air and moisture; hence, straw requires to be mixed with other decomposing substances, such as animal excrements, and turned over in a heap, before it becomes fit for the purpose of profitable manuring. But this is not the case with green succulent plants; their sap contains albumen and other azotised principles highly susceptible of decomposition, and which readily induce decay on the woody and cellular tissues of the plants, particularly in the green and succulent state in which they exist when the plant is coming into flower."

Green manure, though a very important, facile, and powerful means of enriching the soil, and though known in some forms to the ancient Romans, and practised in others by very many farmers of the present day, has received surprisingly little attention from scientific agriculturists, and is even unrecognised in name by multitudes of cultivators. Specific green manure may be regarded as at present practically unknown among the farmers of Britain; residual green manure from cultivated plants is known principally in the form of breaking up lea-grounds and ploughing clover lands, and partly in the practices of some kitchen gardens and in the ploughing in of the leaves and tops of turnips; and incidental or waste green manure is known only in such a fitful and scattered manner as places it beyond the limits of all system. "The chief causes of the neglect of green manure," says Mr. Shier—though his remarks apply mainly to special green manure—"are, first, the want of a due appreciation of its value,—second, the lateness of the harvest, and consequent slowness of growth between the time of sowing the plants and that of ploughing them in,—third, its being inadmissible except at particular points of the rotations in common use,—and, fourth, the carrying out to an unwarrantable extent the principle, that green vegetable substances, to be profitably employed as manures, ought to be, in the first place, used as food for animals."

The roots and the lower parts of the stems of the grasses and clovers bear a large proportion, in either bulk or weight, to the parts of the plants which are depastured or mown; the roots also have made a considerable deposit of excretional matter, which acts in an alimentary way upon a succeeding cereal crop; and when the roots and the lower parts of the stems are ploughed into dead incorporation with the soil, both they and the excretional deposit become direct and important fertilizers. But in order to obtain the largest amount of manurial enrichment, the ground ought not to be very closely mown or depastured, and ought to be ploughed up as soon as possible after harvest, while the roots and the residuary stems are still full of juice. "When old pastures are broken up and made arable," says Sir Humphrey Davy, "not only has the soil been enriched by the death and slow decay of the plants which have left soluble matters in the soil, but the leaves and roots of the grasses living at the time and occupying so large a part of the surface, afford saccharine, mucilaginous, and extractive matters, which become immediately the food of the crop, and the gradual decomposition affords a supply for successive years." Nor do the sugar, the mucilage, and the bitter extractive act the less promptly, that they do not of themselves, as Sir Humphrey's language would seem to imply, constitute aliment to the crop, but that they pass rapidly into decomposition, and give up their elements, and particularly their carbon, as aliment.

Weeds and other kinds of vegetable waste are usually gathered in so irregular a manner as to be available only for the compost heap; and some also are occasionally gathered when in seed, so that to use them as manure would be to sow and propagate them,—while others are either ligneous or otherwise so slow of decomposition as to be intrinsically unfit for green manure. The parings of hedges and ditches, in particular, commonly contain so many of the seeds of weeds, that they ought always to be thoroughly decomposed in the compost heap before being used as manure, and never ploughed in green. Yet some weeds —such as nettles and ferns from a neighbouring common or waste ground, or thistles, black mustard, the common scabious, and other corn-field pests of badly-kept farms—might readily be obtained in sufficient quantity, and at the proper season, to serve as green manure for turnips. The weeding of the last corn crop of a rotation could easily occur at the same time as the preparing of the turnip ground; and it might be accompanied also by the weeding of the docks, thistles, chenopodiums, and other bulky nuisances which are sometimes allowed to grow in great profusion about the farm-stead, and which, if permitted to stand a few weeks later, will shed their clouds of seeds like a vegetable pestilence over the farm. "Should the weeding proceed simultaneously with the preparation of the turnip-ground," says Mr. Gorrie of Annat Cottage, "let the drills, in place of the ordinary width of 27 inches, be opened at about 32 inches from crown to crown; then let a moderately thick layer of weedings be laid in them, taking care to tread them in, so as they shall be completely covered with the soil in forming the drills for the seed; it will be useful to pass a heavy roller over the ground so manured after sowing. A small part of a field of turnips which was dunged with green manure, as here described, was sold by auction by the square fall. That portion manured with green weeds was purchased by a neighbouring farmer who witnessed the process at 1s. 6d. per fall,—36 falls being equal to one rood imperial; the rest of the field, where farmyard partially fermented manure was used, only brought 1s. 3d. per fall, although the drills were a half foot narrower, and consequently more length of drill in the area. It is proper to mention, that one year when green manure was applied in drills of 27 inches, the weeds were imperfectly covered, and dry weather succeeding, the experiment, as far as the turnips were concerned, was a complete failure; but the subsequent crops bear testimony to the excellence of the manure."

The suitableness of ferns, nettles, and the tops of potato plants for green manure, particularly of the first of these, was put to the test of experiment by the late Mr. Knight. "In the beginning of June," says he, "a small piece of ground was planted with potatoes of an early variety, and in some rows green fern, and in others nettles, were employed instead of other manure; and subsequently, as the early potatoes were taken up for use, their tops were buried in rows in the same manner, and potatoes of the preceding year were placed upon them, and buried in the usual way. The days being then long, the ground warm, and the decomposing green leaves and stems affording an abundant moisture, the plants acquired their full growth in an unusually short time, and afforded an abundant produce, and the remaining part of the summer proved more than sufficient to mature potatoes of any early variety. In this experiment, the potatoes grew in ground which, though not rich, was not poor; and therefore some objections may be made to the conclusions I am disposed to draw in favour of recent vegetable substances as manures. The following experiment is, I think, decisive. I received from a neighbouring farmer, a field naturally barren, and so much exhausted by ill management, that the two preceding crops had not returned a quantity of corn equal to that which had been sown upon it. An adjoining plantation afforded me a large quantity of fern, which I proposed to employ as a manure for a crop of turnips. This was cut between the 10th and 20th of June; but as the small cotyledons of the turnip-seed afford little to feed the young plant, and as the soil, owing to its extreme poverty, could not afford much nutriment, I thought it necessary to place the fern a few days in a heap to ferment sufficiently to destroy life in it, and to produce an exudation of its juices, and it was then committed in rows to the soil, and the turnip-seed deposited with a drilling machine over it. Some adjoining rows were manured with the black vegetable mould obtained from the site of an old wood pile, mixed with the slender branches of trees in every stage of decomposition; the quantity placed in each row appearing to me to exceed more than four times the amount the vegetable mould, if equally decomposed, would have yielded. The crop succeeded in both cases; but the plants upon the green fern grew with more rapidity than the others, and even than those which had been manured with the produce of my fold and stable-yard, and were distinguishable in the autumn from the plants in every other part of the field by the deeper shade of their foliage."

The loppings and prunings of very succulent ligneous plants, or unseeding vegetable gatherings from among woods and coppices of any kind which will pass rapidly into decomposition, may also be used as green manure. The prunings of vines have been very successfully employed, in some experiments on the Continent, if not positively to fertilize vineyards, at least to maintain them during a considerable series of years in an undegenerating and very fructiferous condition. The leaves of trees in British woods, though not capable of being used as a green manure, are so exceedingly fertilizing, when employed for litter in the farm-yard and made a constituent of very old farm-yard manure, that they abundantly deserve the attention of all farmers who can obtain permission from the proprietors of the woods to gather them. But the proper way of treating them is to accumulate them in pits or in large heaps at the beginning of winter, to let them lie in that state during twelve months, and then to drive them to the cattle-yard to be used in the manner of litter.

The trimmings of box-edgings serve well as green manure, and are sometimes obtainable in sufficient quantity to be worthy of attention. "In the garden, about the season of planting early potatoes," says Mr. Gorrie, "is also the season for clipping box-edgings; and where the box is 5 or 6 inches high, as is often the case in the garden of the farmer, an expert hand would soon mow a large heap of trimmings with the scythe in the twentieth part of the time, and to much better purpose, than could be done with the box-scissors. From long-established prejudice, the trimmings of box have been considered pernicious to soil, and hence they are generally swept away, and removed as a nuisance; but let them have a fair trial, that is, plant row for row of potatoes with farm-yard dung and box-trimmings, and the returns will be found equal in weight, with this difference in favour of box, that the tubers are more equal, fewer small, and the quality drier than when planted with dung. My experience in this case only extends to where the soil is what is termed strong black loam. Carrots, too, prosper well where box-trimmings are dug in."

Potato haulm, though considerably withered and dried before the tubers are ripe, possesses even then enough of succulency to be advantageously used as a green manure, and at the same time is so rich in potash as to be valuable in any condition on the field, whether succulent or almost wholly dried. The practice of allowing potato haulm to lie and wither away and bleach on the surface of the field, or of gathering it into heaps with the harrows, and using it either as a rough litter in the cattle yard, or as a covering for the potatoes in the potato-pits—this practice, which prevailed throughout almost all field-potato-culture, up to the signal era of the potato rot, and which will probably be continued to any extent to which the potato may yet be found cultivable, is exceedingly wasteful, and ought to be zealously condemned. Allowing the haulm to lie for a long time scattered on the surface of the field, dissipates the greater portion of its organic constituents gaseously into the atmosphere; using it in the manner of litter, occasions much of its saline portion to sink to the bottom of the yard, and be lost; and employing it to cover the potato pits, combines the two evils, and causes a great waste of both the organic and the saline matters. "Where the stems are luxuriant," says Mr. Gorrie, "it is best to have them all hand-pulled, and carted off to a clover-lea field where wheat is to be sown, before the plough enters to turn over the furrows. This is a more cleanly practice than leaving the stems on the ground till gathered by the harrow; and it also prevents any root-weeds from being carted off and ploughed in, a few of which may still be found in potato fields at the time of taking up, especially in wet seasons. After the stems are thus removed, and those tubers gathered which came up with them, the plough meets with no choking in splitting out the drills of potatoes; and every root-weed, if any, is then easily seen, and should be hand-picked after the harrows. This operation over, it is time to have the clover-lea ploughed. A boy with a fork must accompany each plough to push in the stems, so as they may all be regularly and completely buried. The stems on five acres, if moderately luxuriant, will manure one acre well, and the wheat will appear more luxuriant than on the neighbouring ridges, where from 15 to 20 tons of farm-yard dung may have been applied."

The leaves and tails of turnips have begun, in some places, to be treated as green manure, and well deserve to be everywhere so treated. The leaves are seldom relished or eaten by cattle after November; and such of them as are not previously used, amount to great aggregate bulk, and in common usage are so long and thoroughly exposed to the air, either on the open ground or on the dunghill, as to lose all their organic constituents before any part of them can be returned to the soil. The tails, as well as tops, of all turnips, which are stored between November and the earliest appearance of spring growth, ought to be left in the field, or struck off on the spot with a piece of a sickle or with a curved knife; and, to secure the regularity of their distribution, and prevent waste by the aeriform dissipation of their substance, and obtain all the advantage of the succulency of their condition, they ought to be deposited evenly between the drills, and ploughed into the ground on the same day on which they are separated from the bulbs. Turnips proper to yield their tops and tails in this way, comprise the whole of crops which are to be followed by winter wheat, the portions of winter-standing crops which require to be stored in provision for severe weather, and all the parts of winter-standing crops which continue in the field at the commencement of spring growth. Dr. Shier strongly recommends the use of this kind of green manure, and says, "The grain grown after it has always been found to be of fine quality, and not liable to be lodged. With the view of ascertaining the comparative value of this method, I have several times had the produce weighed from two parts of the same field, the one treated in this manner, the other eaten off by sheep; and have found the balance, both in quantity and weight of grain, in favour of the ploughing in of the tops and tails. Unless where wheat is to succeed turnips on a soil so light and friable as to demand the treading of the sheep for textural improvement, this method of green-manuring deserves a trial. The only peculiarity of subsequent treatment that needs to be noticed, is, that the braird of the grain crop requires more rolling than usual, and with a heavier roller. From many trials made in the months of November and December 1842, I find that the ratio by weight of the tops and tails to the bulbs is, on an average, as 1 to 3·3. But 25 tons of bulbs per imperial acre is considered a good crop; and this would give 7 tons 11 cwt. 2 qrs. of tops and tails, which should produce as great an effect on the succeeding crops as a dose of 10 tons of well-prepared farm-yard manure. Of turnip leaves no accurate analysis, so far as I am aware, has yet been published; but they are known to contain a considerable proportion of saline and earthy matter, not to mention the purely organic part, capable of nourishing the succeeding crops of the rotation. If Sprengel's estimate may be relied on, namely, that green turnip leaves contain 1·8 per cent of inorganic matter, the quantity above-specified would contain 303½ lbs. Now when the effect of a much smaller dose of mixed saline manures is considered, it will not appear strange that so much stress has been laid on ploughing in green turnip tops, as a means of enriching the soil and securing good aftercrops."

But crops specially raised for the purpose of being ploughed entire into the soil, constitute the most eminent kind of green manure; and are in the predicament, among British farmers, of being almost totally unknown, and yet abundantly deserving of attention. The use of a special green manure, indeed, can only postpone and never supersede the necessity for farm-yard manure or for some equivalent to the most nitrogenous, phosphatic, and comprehensive saline portions of that compost; yet it is a resource of great value in all situations where ordinary manures are scarce or very expensive, and is peculiarly applicable in cases of short rotations upon stiff clay soils; and if a plant of rapid growth and speedy maturation were used, it might, in favourable seasons, especially in the warmest districts of Britain, be employed as an intermediate operation between the last cleaning process of the summer fallow, and the sowing of the winter wheat.

Some species of lupine figures in very ancient agricultural writings as an excellent manure, and is known to have been cultivated by the ancient Romans; and the white lupine, which has a stem as strong as that of the bean, and attains a height of two or three feet, and abounds in gluten, and grows well in sandy or loamy soil, is at present extensively raised as a green manure in Tuscany, and is usually ploughed into the ground in October. Vetches, pease, aftermath clover, spurrey, rape, rye, buckwheat, and several other leguminous, gramineous, and herbage plants, have been recommended as special green manure; and while all are more or less suitable for the general purpose, they offer the important advantage of severally possessing peculiar adaptation to particular soils, situations, and courses of cropping. But whatever one be employed, it ought, if possible, to be ploughed in either while it is passing into flower or is in actual bloom, for it then possesses its maximum of easily soluble and alimentary matter; and it ought also to be deposited only deep enough to prevent the drying action of the air, and not so deep as to be excluded from the free and abundant play of oxygen which is requisite for its decomposition.—Sea-weed is sometimes spoken of as a green manure; but it operates, in a large degree, by the force of its peculiarly saline character. See the article SEA-WARE.

GREENSAND. A subseries of sedimentary rocks, of the secondary formation. Its geological place is in the chalk group, and is separated from the lowest rocks of the tertiary formation, only by the subseries of proper chalk. It comprises three members, called the upper greensand, the gault, and the lower greensand. It, of course, occurs only in the chalk districts; and, in consequence of its being overlain by both the proper chalks and the tertiary rocks, it crops out in but a small aggregate area, and makes an inconsiderable figure as a surface rock. The firestone quarried between Godstone and Reigate, in the south of England, belongs to the upper greensand; the Black Down Hills in Devonshire consist unitedly of the upper greensand and the lower greensand; the whetstones obtained from these hills consist of greensand; the tract called the Black Land in the vicinity of Godstone consists of gault; and the calcareous stones quarried for burning and for building in the vicinity of Ashford, and also the building-stones raised in the vicinity of Maidstone and elsewhere under the name of Kentish rag, belong to the lower greensand.

GREEN-SCOURING. See DYSENTERY and DIARRHŒA.

GREENSHANK. A British bird, of the scolopacidæ or snipe and sandpiper tribe. Its total length is about 12 inches; its beak is about 2 inches long, and nearly black; the upper part of its body is ashy brown; its breast, its belly, and its tail are white; and its legs and feet are olive green. It is but a summer visitor of most parts of Britain; and is generally rare, and everywhere shy. It frequents the sides of shallow bays, and marine pools on the beach; and feeds on insects, worms, molluscs, and crustaceans. Its eggs are 2 inches long, and upwards of 1¼ inch broad, and have a pale yellowish green colour, variegated with dark brown and light purplish grey.

GREENSTONE. A very common trappean rock. It had an igneous origin, and presents geognostic appearances, closely akin to those of basalt; it frequently passes almost imperceptibly into that rock, or is found in juxtaposition with it in the same hill, or even in the same quarry; and it differs lithologically from basalt and sienite, only in the aggregation of its parts and in the character of its felspar. The constituents or ingredients of greenstone are so aggregated as to appear quite distinct from one another; and its felspar is less crystalline than that of sienite, and usually has a white or greenish colour. Greenstone abounds in the trap districts of Britain; and is a somewhat common and usually an excellent macadamizing "road-metal;" and possesses great interest to the agricultural geologist on account of the usually fertile character of the soils or gravels which it has largely contributed to form.

GREENWEED. Several species of shrubby leguminous plants, of the genista genus,—particularly the dwarf English, the dyer's, and the branching species. See the article GENISTA.

GREVILLEA. A genus of ornamental, evergreen, Australian shrubs, of the protea tribe. About 40 species were introduced to Britain during the years 1790—1835; and a number more are known. They possess great neatness and beauty, and have pretensions of the same kind as the superb banksias, but in an inferior degree. Nearly all bloom from the beginning or middle of spring till the middle of autumn; and most have flowers of pink, crimson, purple, violet, orange, or carmine colours. The height of the greater number ranges from 3 to 5 feet. One of them, *G. rosmarinifolia*, was ascertained about 10 years ago to be quite hardy enough to stand constantly in the open ground in the south of England; and probably others may become so acclimated as to contribute their fine features to conspicuous spots and select groupings in our shrubberies.

GREWIA. A genus of tender, ornamental, evergreen, tall shrubs, of the lime-tree tribe. Most of the species are natives of India and other tropical countries; about 30 have been introduced to Britain; and upwards of 30 others are known. Most have naturally a height of about 10 or 12 feet. Their leaves resemble those of the elm; and, in some instances, are used for feeding cattle in the lower parts of the Himmalayan mountains. The flowers of about one-half are white or yellow; and those of most of the rest are purple. The fruit of many is pleasantly subacid; and that of some is used in India partly for the dessert, but chiefly for making sherbet.

GREYHOUND. See DOG.

GREYWACKE, or GRAUWACKE. A name originally applied by Werner to a fragmented or recomposed rock, consisting of mechanically altered portions or fragments of quartz, indurated clay slate and flinty slate, cemented by a basis of clay slate,—the imbedded particles not exceeding a few inches in diameter, and sometimes becoming so minute as to be no longer visible, when the rock was denominated *grauwacke slate.* As this formation came to be examined more extensively in other countries, the term *greywacke* was extended so as to embrace nearly all fragmentary rocks, whose mechanical structure comes within the above description, however diversified the ingredients may be in their nature and dimensions, or whatever may be the nature of the cement, whether siliceous or argillaceous, provided only they are anterior to the new red sandstone and coal formation. The reason of this extension was, that the greywacke of Werner was found to pass by insensible degrees into rocks, which, notwithstanding they were obviously produced by the same causes, and occupied the same relative situations with his rock, were nevertheless excluded from coalescing with it by the too limited character of his definition. So much diversity, however, exists among the varieties of this rock, that it has been found convenient to distinguish them by separate names. Thus we have *greywacke slate* when the ingredients are very comminuted, *greywacke* when they are of middling size, *pudding-stone* when they are rounded, *conglomerate* when they are from four or five inches in diameter to the size of a man's head and larger, *gritstone* when the concretions are hard and siliceous, and the paste siliceous also, and *old red sandstone* when coloured red by the peroxide of iron. The fragments which compose the rocks of this formation, are evidently the debris of the primary rocks that have been broken down by some powerful catastrophe, and mixed with more recent beds at the period when they were forming. They occupy a place next to the primitive rocks, often in an alternating series with mountain limestone, and beneath that class of rocks denominated *secondary*, between the formation of which and the greywacke a considerable period must have elapsed, as the fragments of the latter invariably consist of lower rocks, and never of the upper strata. Greywacke but very rarely contains organic remains; but the limestones and slates, with which it alternates, present them in considerable quantity, and such as belong to genera almost exclusively unknown at present, and which never occur in the upper strata. Though the gold of Hungary and Siberia is found in this rock, still it cannot be said to be prolific in metals or other useful minerals. When fine grained, it forms a valuable building stone. Greywacke is very extensively distributed in Europe. It forms the eastern declivity of the mountains of Brazil, and abounds throughout the chain of the Alleghanies.

GRIAS. An evergreen, tropical fruit-tree, of the guttiferous order. It constitutes a genus of itself, and is specifically called *cauliflora* or the stem-flowering. It has naturally a height of 50 or 60 feet, and has been popularly styled the anchovy pear. Specimens occurred, so far back as about 80 years ago, in British hothouses.

GRIEVE. See Agent.

GRIFFINIA. A genus of tender, bulbous-rooted, ornamental plants of the amaryllis order. The hyacinthine or violet-coloured species, *G. hyacinthina*, was introduced to Britain from Brazil in 1815, and was for some time regarded as a true amaryllis. Its leaves are ovate-oblong, recumbent, and beautifully latticed by veins crossing the longitudinal nerves; its flower-stem is about a foot in height; and its flowers are produced in a sub-capitate umbel, and are funnel-shaped, gaping, and of six segments, with a pure white centre, and a broad ultramarine blue margin, peculiarly soft in the texture and rich in the tint,—and they bloom from June till September. This plant, though so long introduced and so very beautiful, is still comparatively rare. It grows well in equal parts of turfy loam, peat, and white sand. Two other species, the small-flowered and the intermediate, have been introduced.

GRINDELIA. A genus of ornamental, yellow-flowered, exotic plants, of the thistle division of the composite order. It is somewhat allied to the asters, and very nearly allied to the donias. Five half-tender, evergreen, small, shrubby species of it, two or three half-tender, evergreen, herbaceous species, and one hardy biennial species, have been introduced to British collections.

GRINDERS. The large teeth used for mastication. See the articles Tooth and Age of Animals.

GRINDING. The pulverizing of a hard solid substance by the combination of pressure and a twisting or rotatory action upon a resisting basis. Grinding by means of the rotatory pressure is the method of pulverizing commonly practised upon grain, drugs, and other bulky articles of commerce; and grinding by means of the twisting action effects the pulverization of road-metal by means of carriage-wheels, and constitutes a large proportion of the friction by which the motion of carriages is retarded, and the gravity and resistance of their draught are increased. "The grinding of wheels," says Fry, "may in every case be defined to be the effect produced on any substance interposed between two bodies, one of which has a sliding motion, yet so firmly confined or pressed between them that the moving body cannot slide over the interposed substance; but, in consequence of the pressure, the interposed substance, adhering firmly both to the fixed and to the moving body, is necessarily lacerated or torn asunder, and reduced to atoms. This is the process in corn-mills, in drug-mills, and in every other mill, properly so called. I remember frequently when a boy, to have trodden with one heel on a piece of soft brick, or of dry old mortar, which was firm enough to bear the weight of my body uninjured; but, on giving my body a swing round with my other foot, I have instantly reduced it to powder. The action in this case is very obvious; the weight of my body confined the piece of brick firmly to the ground; my heel was also pressed by the same weight firmly upon the brick; one part of the brick therefore, remaining confined to the ground, and the other part being carried round by my heel, the brick of course was torn asunder and reduced to powder. This I conceive is a simple elucidation of the difference between pressing and grinding; and this is the difference of the effects on the materials of our roads, produced by the use of upright cylindrical wheels, which act only by pressure,—by the use of conical wheels, which, by their constant twist, act also by grinding,—and by very convex roads, by which means the wheels of all carriages, except such as occupy the crown of the road, whether cylindrical or otherwise, act in the same twisting, sliding, and grinding manner." See the articles FLOUR, MILL, and WHEEL.

GRIP. A water-furrow; also, the urine gutter of a cow-house or a cattle-shed.

GRIPE. See GRAIP.

GRIPES. See COLIC.

GRISLEA. A small genus of ornamental, evergreen, tropical shrubs, of the lythrum tribe. The downy species, *G. tomentosa*, grows wild in China, throughout India, and in the islands of the Indian Ocean; it abounds in the jungles at the base of mountains; and it was introduced about 43 years ago to the hothouses of Britain. Its stem usually attains a height of 3 or 4 feet; its leaves are opposite and entire, and are marked on the under-surface with dark-coloured glands; and its flowers are produced on axillary footstalks, and have a reddish colour, and bloom in May and June,—but, in their wild state, they retain the bright red of their calyxes till their seeds are ripe, and in consequence give the whole plant, for a long period, a very showy appearance. This plant is a handsome ornament of our stoves; and its flowers are used in India as an astringent medicine, and particularly as a red dye-stuff. Another species, the side-flowering, *G. secunda*, has been introduced from tropical America.

GRISTLE. See CARTILAGE.

GRIT. Any hard, coarse-grained, sedimentary rock, suitable for millstones, grindstones, pavement-stones, or other economical purposes which require hard and regularly stratified stones. Geologists speak particularly of the calcareous grit and the millstone grit, the former an oolitic sandstone with but little calcareous matter, and the latter a coarse and irregularly laminated rock with beds of quartz pebbles; and workers in stone often loosely apply the name grit to any kind of workable sandstone which is not fine-grained and does not take a very smooth surface,—and speak, with little reference to either geological or lithological character, of red grits, white grits, grindstone grits, millstone grits, and some other kinds of grits.

GROATS. The grains of oats freed from the husks. Embden groats are common groats crushed. Groats are peculiarly suited for making a mild, nutritious, and easily digestible gruel, such as may be used by patients in fevers and inflammations.

GROGGINESS. A diseased tottering of the fore-leg of the horse. It is nearly allied to founder; but has a diversity of character, and cannot very easily be defined. It is distinguishable from chronic founder, principally by the animal seldom pointing his foot, and by his not altogether faltering,—and frequently also by a more elevated direction of the pastern. It usually arises from excessive working, and especially from much journeying at a rapid pace: and it may often be observed in oldish overworked horses. It can seldom if ever be cured after it has been fully formed; and requires sharp practice with paring, blistering, and setoning for a cure, even when it is treated from an early stage of its existence. Blaine regards it as a disease of the navicular joint.

GROMWELL,—botanically *Lithospermum*. A diversified genus of plants, of the borage tribe. Its seeds are extremely hard, and have a surface like that of polished pebbles; and hence the name Lithospermum or stone-seed.

The common or officinal species, *Lithospermum officinale*, is a perennial-rooted herbaceous indigen of chalky soils, gravelly banks, and rubbishy spots in various parts of Britain. Its root is strong, tapering, and whitish; its stem is leafy, branched, and about two feet high; its leaves are alternate, sessile, ovate, and greyish-green; its flowers grow singly at every joint of the small branches, and have a pale buff colour, and bloom from May till August; and its seeds are grey, and look almost like polished pieces of pottery, and have been erroneously supposed to contain calcareous earth, and might, in seasons of scarcity, be ground into meal and converted into bread. A decoction of this plant was formerly esteemed an excellent diuretic and a powerful remedy for gravel and other diseases of the urinary organs.

The corn-field species or bastard alkanet, *Lithospermum arvense*, is an annual weed of the waste grounds and corn-fields of Britain; and is sometimes particularly abundant in fields of rye. Its root is tapering and has a bright red bark; its stem is rough, branched, and about two feet high; its leaves are alternate, spear-shaped, narrow, and rough; and its flowers are white and small, and bloom in May and June. The red bark of the root stains paper, linen, oily substances, and the human skin; and is sometimes used as a rustic substitute for rouge, and as a colouring matter of ointments; and these uses of it are alluded to in the name bastard-alkanet.

The creeping or purple-blue gromwell, *Lithospermum purpuro-cœruleum*, is a perennial-rooted native of umbrageous chalky soils in England. Two or three trailing stems, about a foot in length, grow from each root; the leaves are alternate, and long, narrow, spear-shaped; and the flowers are purple-coloured, and bloom in May.

The dyer's species, *Lithospermum tinctorium*, called by Willdenow *Anchusa tinctoria*, is a hardy, ornamental, blue-flowered, perennial-rooted native of the sea-board of the Mediterranean; and was introduced to Britain before the close of the 16th century; and was formerly celebrated in some degree as a medicine, but chiefly for the colouring matter yielded by its roots.—Three hardy annuals, one hardy biennial, one evergreen ligneous trailer, two evergreen undershrubs, and several hardy perennial-rooted herbs, have been introduced to Britain principally from continental Europe; and between 20 and 30 additional species are known. Most of the introduced ones figure well in the parterre, and the greater number are blue-flowered.

GRONOVIA. A small genus of curious, biennial, climbing, tropical plants, of the gourd tribe. The climbing species, *G. scandens*, is a native of the West Indies, and was introduced about 120 years ago to Britain. Its trailing stems or branches grow out like those of the cucumber, and are closely set with broad green leaves, and provided with many tendrils; the leaves are shaped like those of the vine, but are covered on both sides with small spines, which sting like the nettle; the tendrils give the branches a facile climbing character, and readily raise them to the height of 6 or 8 feet; and the flowers are greenish-yellow and very inconspicuous.—Humboldt's species, of rather taller habit than the preceding, was introduced nearly 30 years ago from South America.

GROOM. A servant who attends to the stable, and feeds, grooms, and litters horses. He ought to possess a thorough knowledge of the wants and habits of horses, to exercise much patience and skill in the management of the particular animals in his charge, and to practise regularity and care in the performance of his several duties both upon the animals themselves and upon their stable.

GROOMING. The combing, brushing, and hand-dressing of a horse. Every horse which is kept much in the stable, or is highly fed, or is little worked, requires grooming as a substitute for defective exercise; and every horse which is demanded by taste or fashion to have a spruce and glossy appearance, requires grooming as the only healthy means of maintaining a good "coat." But the curry-comb needs to be but lightly applied to any horse, and not applied at all to a horse with thin or tender skin; and a soft brush or even a hair cloth, aided by a little additional pressure of the hand, will, in many instances, effect all the purposes of an efficient grooming. A farm-horse, or any horse whatever, which is hard worked during the day and turned into the field at night, would be injured rather than benefited by any further grooming than the mere brushing of the dirt from his legs. See the article Dandriff.

GROSSULARIA. The gooseberry-shrub. See the article Gooseberry. The natural order grossulariaceæ comprises the currant and gooseberry genus, or genus *ribes*, and differs from the cactus family principally in having woody and leafy stems and a definite number of stamens.

GROUND. Any dry part of the surface of the earth; or any part which is capable of cultivation or profitable employment; or a stratum of soil; or a piece of dry grass land as contradistinguished from a meadow.

GROUND BEETLE. A coleopterous insect, whose larva is found in corn-fields, and has been supposed by some persons to injure corn similarly to wire-worms, and by others to feed upon these depredators, but whose genus, or even whose imago, seems not yet to be ascertained. Mr. Curtis queries it to be a Harpalus; and, speaking of some dead specimens of its larvæ which were sent to him from Devon, says, "I cannot determine what beetle they would produce, but probably some carabideous species, in which case I should be rather disposed to consider that they lived upon the wire-worms, &c., but this is not a natural consequence, for although most of the Carabidæ are carnivorous, there are some which feed upon the corn-crops both in their larva and beetle states. This larva is 4½ lines long, hairy, of an ochreous colour, having an enormous head, but tapering towards the tail, which is rust-coloured; the face is sloped off gently, with a group of minute black dots on each side, looking like eyes; the two antennæ are porrected, slender, hairy, and five-jointed; the jaws are very strong, not crossing, semilunate, toothed internally, the apex appearing pointed, but it is rounded and black; the maxillæ are elongated, as well as the labial palpi, which are bi-articulate, the basal joint being the stoutest, the second long, incurved, slender, and tapering; the maxillary palpi are shorter, and bi-articulate; the first thoracic segment is very broad and strong, of a ferruginous tint, the two following and the eight abdominal segments are of a dull ochreous tint, gradually tapering to the tail, which is furnished with a prehensile foot and two longish, tapering, articulated feelers; the sides of the body are margined and plaited; it has six pectoral jointed legs, spiny, and terminated by two long claws."

GROUND-CHERRY,—botanically *Cerasus chamæcerasus*. A small, ornamental, shrubby species of cherry-tree, introduced to Britain from Austria, near the end of the 16th century. See the article Cherry.

GROUND-CISTUS,—botanically *Rhododendron chamæcistus*. A dwarfish, hardy, ornamental, evergreen undershrub, 5 or 6 inches high, carrying pale purple flowers in May and June, and introduced about 60 years ago from Austria. See the article Rhododendron.

GROUND-CYPRESS,—botanically *Santolina chamæcyparissus*. A beautiful, hardy, small, evergreen shrub, of the lavender-cotton genus. It carries yellow flowers in July; and was brought from the South of Europe in the 16th century.

GROUND-IVY,—botanically *Glechoma*. A small genus of hardy trailing plants, of the labiate-flowered order. The common or native species is the principal one. See the article Alehoof. The hairy species is a curious pink-flowered plant from Hungary, and blooms at the same time as the alehoof.

GROUND-JASMINE. An ornamental, evergreen, white-flowered, Siberian undershrub, of the wild olive-tree family. It is regarded by some botanists as a Stellera, and by others as a sparrow-wort. It grows about 12 or 15 inches high, and blooms in June and July.

GROUND-PINE. A beautiful, yellow-flowered, 6 or 8 inch, annual, labiatous indigen of the sandy fields of some parts of England,—*Ajuga chamæpithys;* also a handsome, yellow-flowered, 4 or 5 feet, evergreen, Australian proteaceous shrub,—*Persoonia chamæpithys.*

GROUNDSEL,—botanically *Senecio.* A very large and diversified genus of plants, constituting the type of a division of the composite order. This division comprises the beautiful genera cineraria, tagetes, and kaulfussia, the well-known genera senecio and tussilago, and nine other genera. Nine species of the genus senecio are indigenous in Britain, and about 100 other species occur in our gardens and our botanical collections.

The common groundsel, *Senecio vulgaris*, is one of our most abundant annual weeds. It flourishes in almost all sorts of situations, in fields and gardens, in waste grounds, in rubbish, on dry banks, on the tops of earthen walls, and wherever it can obtain even the smallest patch of bare dry soil. It flowers and seeds throughout a great part of the year; and, its light downy seeds being wafted away by the slightest breeze, it is in an almost constant course of dissemination. The plant is so universally known in the country, and so generally known even in towns, as not to need any description. The leaves, the flower-buds, and the seeds of it are much relished by cage-birds, especially finches and linnets. The plant is eaten by goats and swine, ill-relished by cattle, and totally refused by sheep and horses. An infusion of it in small dose, is a purgative, and, in large dose, acts as an emetic, and is sometimes given to horses, though quite uselessly, to expel bots from their intestines.

The common ragwort, *Senecio jacobæa*, is a very abundant weed on many dry pastures, and infests almost every kind of dry grassy ground. It particularly abounds in many of the grass lands of Ireland, and in the grass lands of bad British farmers, and greatly detracts from the productiveness of the pastures. Its root is perennial and somewhat fleshy; its stems are upright, striated, corymbly branching, and about two feet high; its leaves are alternate, doubly pinnatifid, smooth, deep shining green, and able to resist the withering effects of the utmost heats and droughts of our climate; its folioles or leaf-segments are cuneiform, spreading, and sawed; its flowers grow in corymbose panicles, and on downy footstalks, and are numerous, and have a bright yellow colour, and bloom in July and August; and its seeds have a rough down, and are covered with silky hairs. This plant remains untouched by cattle as long as they can find anything else to eat; and it emits a fetid odour when bruised. It has been recommended, though rather quackishly, as a remedy for cancer. The prevalence, or more than the bare existence of this plant, but especially the seeding of it, on any land, is disgraceful to the farmer, and affords a distinct indication of his being either too sick, too lazy, or too ignorant to attend to his business. Seeding may of course be easily prevented by cutting over the plant when coming into flower; and even extermination is easily effected by pulling up the plants after rain. The common ragwort has many popular and provincial names,—among others, ragweed, staggerwort, stinking elshender, swine's cresses, St. James'-wort, seggrum, and Scotch canker-weed.

The Saracenic or broad-leaved ragwort, *Senecio sarracenicus*, is a somewhat rare weed of Britain; yet sometimes occurs in moist meadows and in waste spots of wet grassy ground. Its root is perennial and creeping; its stems are erect, smooth, solid, full of pith, corymbly branched, and from 3 to 6 feet high; its leaves are sessile, irregularly produced, undivided, broadly spear-shaped, serrated, smooth, shining, bright-green, and somewhat downy; its flowers are corymbose and numerous, stand on downy angular footstalks, have a bright yellow colour, and bloom from July till October; and its seeds are short, angularly obovate, smooth, and silky. This plant has acrid and astringent juices; and it is supposed to have acquired its name of Saracenic from the circumstance of the Saracens having used it as an application to wounds.

The marsh ragwort, or great fen ragwort, or bird's-tongue, *Senecio paludosus*, is also a rare weed in England, and does not occur wild in Scotland. It is occasionally found in some of the English fens. Its root is perennial, fibrous, and creeping; its stems are erect, hollow, loosely downy, and usually about 5 feet high; its lower leaves are dilated and equally sawed at the base; its upper leaves are contracted; all its leaves are entire, spear-shaped, tapering, serrated, smooth above, and somewhat downy below; its flowers are corymbose, large, conspicuous, bright-yellow, and fewer than those of some of the other species, and bloom from June till August. This plant, in spite of its weedy and stalwart character, has a decidedly ornamental appearance.

The water groundsel, or water ragwort, *Senecio aquaticus*, is a perennial-rooted weed of marshes, river banks, pond-margins, and other watery places in both England and Scotland. Its stems are usually about 3 feet high; its lower leaves are entire and obovate; its upper leaves are divided, lyrate, and serrated; its flowers are corymbose, large, and comparatively few, and have spreading rays and a golden yellow colour, and bloom in May and June. This species has considerable affinity to the cinerarias, and yet is very plain and coarse in its appearance.

The slender-leaved or hoary ragwort, *Senecio tenuifolius*, is a perennial-rooted weed of hedge-banks, of road-sides, and particularly of woods, in the calcareous and gravelly districts of Britain. Its root has long and strong fibres, and is somewhat creeping; its stem is erect, branchless, leafy, furrowed, slightly downy, and usually about two feet high; its leaves are alternate, numerous, deeply pinnatifid, dark-green, smoothish above, and downy and hoary below; its folioles or leaf-segments are somewhat revolute; and its flowers are corymbose, and have spreading rays and a bright yellow colour, and bloom in July and August. This species, like the last, has a very uninviting appearance.

The squalid groundsel, or inelegant ragwort, *Senecio squalidus*, is an annual weed on walls and waste places in some parts of England. Its root is fibrous, its stem is erect, leafy, branched, smoothish or but slightly pubescent, and usually about 20 inches high; its leaves are sessile, pinnatifid, sharply sawed, smooth, and bright-green; its folioles are comparatively distant from one another and somewhat linear; and its flowers are loosely corymbose, and have elliptical and spreading rays and a bright golden-yellow colour, and bloom from June till October. This plant has quite a weedy appearance, and a somewhat tansy-like smell.

The wood or mountain groundsel, *Senecio sylvaticus*, is an annual weed of heaths, thickets, and woods, in the sandy and gravelly districts of both England and Scotland. Its root has several strong fibres; its stem is furrowed, wand-like, and 12 or 14 inches high; its branches are axillary and small; its leaves are numerous and divided; and its flowers are numerous, and have revolute rays and a yellow colour, and bloom in July and August. This plant is downy, and has a disagreeable and slightly aromatic smell, somewhat like that of fennel.

The clammy or stinking groundsel, *Senecio viscosus*, is an annual weed of waste grounds and bare banks in the calcareous and sandy districts of Britain. Its stem is spreading, and 12 or 15 inches high; its leaves are deeply pinnatifid; and its flowers have revolute rays, and a bright yellow colour, and bloom from June till October. This plant resembles the common groundsel, but is larger, downy, soft, and glutinous, and has a strong and disagreeable odour.

The Jacobæa or elegant groundsel, *Senecio elegans*, is one of our most handsome exotic hardy or half-hardy annuals, and was introduced to Britain about a century and a half ago from the Cape of Good Hope, and has long been generally cultivated on the borders of flower-gardens. It grows about two feet high, has divided leaves, corymbose flowers, and spreading rays, and may be made to bloom in succession through a great part of the year. The normal plant has single purple flowers; but any one sowing produces varieties, and abounds in double flowers, some of them almost packed with petals. Three half-tender, undershrubby varieties, the white-flowered, the double white-flowered, and the double red-flowered, are particularly handsome.

About 18 of the introduced species of groundsel are ornamental, evergreen shrubs, from Mexico and the Cape of Good Hope, principally yellow-flowered, and varying in height from 2 to 7 feet; upwards of 20 are herbaceous annuals, principally coarse and inelegant, and mostly from the continent of Europe or the shores of the Mediterranean; and the majority of the remainder are hardy, perennial-rooted herbs, of very various appearance between ugly weeds and garden ornaments, from widely distant parts of the world, but principally from Continental Europe.

GROUSE. The genus *Tetrao* of ornithologists, comprehending birds of the gallinaceous order, characterized by a full habit of body, short, concave, rounded wings, legs of moderate size, and having the tarsus completely or partially covered with feathers, a small head, and bare superciliary crests, has by some been divided into two genera, one including the grouse properly so called, which have the toes pectinated with elongated lateral scales, the other including the ptarmigans, of which the toes are destitute of these lateral scales and covered with feathers. Four species of this genus occur in Britain; and two of these belong to the first or grouse section, and are noticed in our articles BLACKCOCK and CAPERCAILZIE; and the other two belong to the ptarmigan section, and are popularly called the Red grouse and the Grey ptarmigan.

The Red Grouse—*Lagopus Scoticus*—is peculiar to Great Britain and Ireland, not having hitherto been observed in any other part of the world. It is a strong full-bodied bird, the male about 16 inches in length, its extended wings measuring 27 on an average. The colour varies a little with the seasons. In winter the adult male is chestnut-brown, inclining to red on the neck; on the body variegated with black; on the breast blackish, with many of the feathers tipped with white. The general colour of the female is yellowish-red, spotted and varied with black. In summer the male is chestnut-brown, minutely varied and spotted with black; the head and neck also varied; the breast darker and more obscurely varied. The female is yellowish-red, spotted and varied with black; most of the feathers on the upper parts tipped with yellowish-white. The superciliary membranes or crests, which are larger in the male, are vermilion, the bill brownish-black, the iris hazel, the claws blackish-brown, greyish-yellow at the end.

Although this bird occurs in Ireland and England, it is more abundant in Scotland, where it is met with on the heaths, from the level of the sea to the height of about two thousand feet. The low sandy heaths of the eastern parts of the middle division appear to be less favourable to it than the more moist peaty tracts of the western and northern districts, where the shrubs on which it feeds attain a greater size. In the central regions of the Grampians it is equally abundant as on the moors of the Hebrides; and on the hilly ranges of the south, the Pentlands, the Lammermuir, and the mountains of Peebles, Dumfries, and Selkirk, it is still plentiful.

The food of this species consists chiefly of the tops of heath, *Erica vulgaris*, *Erica cinerea*, and the leaves and twigs of other shrubs and herbaceous plants. On ordinary occasions, the species does not fly much, but keeps concealed among the heath, seldom choosing to rise unless its enemy comes very near. On the approach of danger, it lies close to the ground, when being of a colour not contrasting strongly with that of the plants around, it is with difficulty perceived by rapacious birds, among which its principal enemies are the Golden eagle, the Peregrine falcon, the Common buzzard, and the Henharrier. The quadrupeds which occasionally prey upon it are the polecat, the Pine martin, the fox, and perhaps the ermine. When traced by a dog, it either runs to some distance, or squats at once. On such occasions the male is generally the first to rise. He erects himself among the heath, stretches out his neck, utters a loud cackle, and flies off, followed by the female and young, affording by their straight-forward, heavy, though strong, flight, an easy mark to a good shot. Young birds often allow a person to come within a few yards or even feet before they fly off, and even the old males, unless previously harassed, rise within shooting distance. In a district where there is choice of situation, the Red grouse prefer the slopes of hills not exceeding two thousand feet high; but they are to be found on the lowest and most level peat-bogs, especially if there are large tufts of heath surrounded by banks. Those which in summer and autumn reside on the heights usually descend in winter; but even during that season, individuals may be found in their highest range, which is bounded less by actual elevation than by the disappearance or scantiness of heath. This species generally flies low and heavily, moving its wings rapidly, with a whirring noise, and proceeding in a direct course without undulations. Occasionally, when at full speed, and especially when descending parallel to a declivity, it sails at intervals, that is, proceeds for a short time with expanded and apparently motionless wings. Its flight is strong, often protracted to a considerable distance, and capable of being urged to a surprising degree of velocity, when the birds have been pursued by a hawk. Although the haunts of the Red grouse are the heathery moors, it has sometimes been found in stubble-fields, or among corn, bordering on uncultivated tracts; and when it finds an opportunity of feeding on oats, it does not scruple to avail itself of it. Unlike the Blackcock, it is seldom or never met with in woods.

The male is not polygamous, nor does he at any time desert his mate. When incubation is over, and the young run about, they are tended by both parents, the female manifesting great anxiety for their safety, and feigning lameness to induce a person who has approached them to follow her. When surprised on the nest, she flies with a low undecided flight to a short distance, and runs off among the heath. The young are soon able to fly, and the flock keeps together until the end of autumn, unless scattered and thinned by sportsmen and vagabonds. Towards the beginning of winter, several flocks often unite and keep together, forming what are called packs. They are then generally more shy, and continue so until the beginning of spring, when they separate and pair, without manifesting any remarkable animosity; for although the cocks may occasionally fight, they have not those regular periodical battles described by authors as enacted by many species of the grouse genus. The nest is found in the midst of the heath, in a shallow cavity, and formed of bits of twigs, grass, and sometimes a few feathers. The eggs are from eight to twelve, or even more, generally an inch and seven-twelfths in length, an inch and three-twelfths across, of a regular oval form, yellowish-white, pale yellowish-grey, or brownish-yellow, thickly clouded, blotched, and dotted with blackish and amber brown. The young leave the nest soon after they are freed from the shell. They are at first covered with a fine close down of a pale yellowish-grey tint, mottled beneath with pale brown, patched above with deep brown, the top of the head chestnut, margined with darker. As an article of food, the Red grouse is highly esteemed. The flesh is very dark coloured, and has a peculiar somewhat bitter taste, which by some is considered as extremely pleasant. The species is capable of living in a state of domestication, and then feeds on grain, bread, potatoes, and other substances, although it always prefers its natural food. A few instances have been known of its breeding in captivity; but, from its habits, it does not seem probable that it could be trained in subjection, like the domestic fowl.

The Grey Ptarmigan—*Lagopus cinereus*—is the only other species of this genus that occurs in Britain, where it is now confined to the summits of the higher mountains of the middle and northern divisions of Scotland. It resembles the Red grouse in form and proportions, the male measuring about fifteen inches in length, and about twenty-five inches between the points oi its extended wings. In winter the male is white, with a black band from the bill to the eye, the tail-feathers greyish-black, barred and tipped with white, the shafts of the primaries brown. The female in winter is also white, the feathers between the bill and the eye black at the base only, the tail-feathers brownish-black, based and tipped with white. In spring both sexes are white, mottled with dark grey, and yellow feathers, which are barred with black; the wings, lower parts, and tail, as in winter. In summer the head, neck, upper parts and sides, are spotted and barred with yellow and brownish-black; the wings, lower parts, and tail, as in winter. In autumn the plumage of the upper parts and sides is finely barred with greyish-white and greyish-black; the head, neck, and sides, retaining the yellow summer feathers longest; the wings, lower parts, and tail, as in winter. The young are spotted and barred with yellow and dark brown; the wings white, the shafts of the primaries dusky; the tail brownish-black, the middle feathers barred with yellow and dark grey.

This beautiful bird is met with in flocks on the bare and weather-beaten summits of the Grampians, and other high mountains of the north, where they reside from the beginning of spring, to the close of autumn, seldom descending into the heathy tracts, unless in winter when the ground is covered with snow. Its food consists of various plants, chiefly of a shrubby nature; twigs and leaves of *Erica vulgaris, Erica cinerea, Empetrum nigrum, Vaccinium myrtillus, V. vitis-idæa, Salix herbacea*, and others, being in fact similar to that of the Red grouse. Its habits are also similar, but it generally allows a much nearer approach, and seems in no degree aware of danger from the proximity of man, remaining squatted on the ground, or on a stone until you almost trample upon it. When in packs, however, it is more shy, although even then it seldom flies off until one comes within shooting distance. While feeding, the ptarmigans run and walk among the lichen-crusted and crumbling fragments of rock, from which it is very difficult to distinguish them when they remain motionless, as they invariably do should a person be in sight. Indeed, unless you are directed to a particular spot by their strange low croaking cry, which is not very unlike that of a frog, you may pass through a flock without observing a single individual. When squatted, however, they utter no sound, their object being to conceal themselves; and if you discover the one from which the cry has proceeded, you generally find him on the top of a stone, ready to spring off the moment you show an indication of hostility. If you throw a stone at him, he rises, utters his call, and is immediately joined by all the individuals around, which, to your surprise, you see spring up one by one from the bare ground. They generally fly off in a loose body, with a direct and moderately rapid flight, resembling, but lighter than, that of the Red grouse, and settle on a distant part of the mountain, or betake themselves to one of the neighbouring summits, perhaps more than a mile distant.

Early in spring they separate and pair. The nest is a slight hollow, scantily strewn with a few twigs and stalks, or blades of grass. The eggs are of a regular oval form, about an inch and seven-twelfths in length, an inch and from one to two-twelfths across, of a white, yellowish-white, or reddish colour, blotched and spotted with dark brown, the markings larger than those of the Red grouse. The young run about immediately after leaving the shell, and from the commencement are so nimble and expert at concealing themselves, that a person who has accidentally fallen in with a flock very seldom succeeds in capturing one. They are at first covered with a light yellowish-grey down, patched on the back with brown, and having on the top of the head a light chestnut mark, edged with darker. When fledged, they are very similar to the young of the Red grouse, but banded and spotted with brighter reddish-yellow. The flesh of the Grey ptarmigan is not so dark as that of the Red grouse, nor quite so bitter, although it has the same flavour. A very considerable quantity is annually killed, the bird being held in estimation not only as an article of food, but, when stuffed, as a domestic ornament.

GROVE. A small and ornamental wood. An open grove consists entirely of trees; and a close grove, in addition to trees, has either an environing or an underwood shrubbery. Groves admit of a vast variety of forms and arrangements, and may be made either principal or subordinate features of a scene; but whenever they are intended mainly for shelter, or often when intended principally for picturesque effect, they ought to have their trees, not in rows, but at scattered distances.

GROWTH. The development of an organized body till it reaches the limits fixed for each species, and for the several organs of the individual.

If different living bodies be examined with attention, we shall find them to be composed of an organic structure, which is obviously essential to such a whirlpool, as that to which we have compared the vital action in our article LIFE. There must not only be solid particles to maintain the forms of their bodies, but fluids to communicate the motion. They are, therefore, composed of a tissue of network, or of solid fibres and thin plates (*laminæ*), which contain the fluids in their interstices. It is among the fluid particles that the motion is most continuous and extensive. Foreign substances penetrate into the innermost parts of the body, and incorporate with it. They nourish the solids by interposing their particles; and, in detaching from the body its former parts, which have now become superfluous, traverse the pores of the living frame, and finally exhale under a liquid or gaseous form. During their course, the foreign substances enter into the composition of the solid framework, containing the fluids; and, by contracting, communicate a part of their motion to the liquid particles within them. This mutual action of solids and liquids, —this transition of particles from the one form to the other,—presupposes a great chemical affinity in their elementary constituents; and we accordingly find, that the solid parts of organized bodies are composed chiefly of such elements as are capable of being readily converted into liquids or gases. The solids would also require to be endowed with considerable powers of bending and expanding, in order to facilitate the mutual action and reaction between the solids and the fluids; and hence, this is found to be a very general characteristic of the solid parts of organized bodies. This structure, common to all living bodies—this porous or spongy texture, whose fibres or laminæ, ever varying in flexibility, intercept liquids, ever varying in quantity—constitutes what has been termed *organization*. See articles FOOD, NUTRITION, and ORGANIZATION.

In general, the term of life among the mammalia is in direct proportion to the time which they severally take in arriving at their full growth, exclusive of the period of gestation. Buffon calculated, from many observations, that they lived seven times the period of growth; but it is very often only six times this period. Among the most remarkable exceptions to the above rule, we find man, with whom the average duration of life is far less than that of other species, relative to his time of growth. As he does not attain his full size until about the age of twenty years, his life ought to average a duration of 120 to 140 years. Several individuals have attained these ages, and some have even passed them; but of those few who survive the first years of infancy, by far the greater number do not pass beyond the ages of seventy or eighty. This anomaly to the rule of Buffon is due to a multitude of circumstances, which it would be premature to detail at present; such as the mode of life, the abundance and excess of food, the want of temperance, and other results of an imperfect and misdirected civilization. For the same reason, the relation which the period of growth bears to the whole term of life, is not without many exceptions among the domestic animals. On the one hand, they receive the influence of a superabundant nourishment, and on the other, are more frequently preserved from those excesses to which this abundance might have given rise. Hence, the duration of life is often prolonged among the domestic animals beyond the term already specified. The growth of the horse being commonly completed in about four or five years, it lives twenty-five or even thirty-five, provided the natural term of its existence has not been shortened, as happens too frequently, by ill treatment of every kind, by violent fatigues, as well as the want of attention and suitable nourishment. This animal presents, notwithstanding, several instances of remarkable longevity, and some individuals have been known to attain the advanced ages of sixty and even seventy years. As the ass takes nearly as long as the horse in reaching its full growth, the duration of its life ought to be nearly the same; yet it often breaks down before that period through injuries or neglect, which it receives most undeservedly from all quarters. It is observed that animals, naturally disposed to chastity, live longer than those of different propensities. The mule and bardeau are usually unable to procreate, and accordingly they live longer than either the horse or ass. Very frequently mules die at the age of forty, and one has been known to attain the age of eighty years. The bull takes about two or three years in growing, and the natural period of its life terminates at fifteen to twenty years. The buffalo approaches the former very nearly in both of these respects; yet it appears to take a little longer time in reaching its full growth, and hence lives to a more advanced age. The sheep has nearly the same period of growth, and also a corresponding period of life. The goat approaches to the same terms, both in respect to its growth, and the duration of its existence; yet the extreme attachment of these two last-mentioned species to sexual propensities serves to abridge the ordinary period of their lives, in those few cases where man does not terminate their existence suddenly for his own advantage. The hog being two years in attaining its full development, may reach the age of fifteen or twenty years, if not fattened before the term of puberty, as is most commonly done, though some old boars have been known to pass far beyond the above-mentioned terms. We may thus perceive that the relation of the period of growth to the duration of life does not remain constant among the domestic animals.

GRUB. A larva which infests the fields of farms, and partially destroys pastures, herbage plants, and cereal crops. The word is sometimes used so very loosely as to designate wire-worms, slugs, and almost all kinds of maggots which occur in the field; it is sometimes used less loosely to designate the larvæ of the most mischievous grass-eating insects, whether dipterous, coleopterous, or hymenopterous; and it is now more commonly, and with very obvious propriety, used in so restricted a sense as to designate only the larvæ of the burrowing species of the dipterous genus tipula.

The flies of this genus have exceedingly long legs and very narrow and elongated bodies; and are popularly or provincially known by a number of curious and expressive names, such as, crane-flies, long-legs, tailors, gaffer long-legs, and Jenny-the-spinners. They frequent meadows and pastures; and the larvæ of many burrow in the ground, and often destroy the sward by loosening and injuring the roots of the grasses. Several species are very common, and at least forty occur in Britain; but all are akin to one another in habits, and may be regarded as fully and fairly represented by the most mischievous one of their number, the meadow crane-fly. See the article TIPULA.

The larva of the meadow crane-fly, *Tipula oleracea*, is so abundantly diffused and so exceedingly mischievous as often to take exclusively to itself the name of the grub. The perfect insect is nearly an inch in length, and of a brownish-grey colour; its palpi are dark-brown; its antennæ are yellowish-grey in the lower-joints, and dark-brown in the other joints; its forehead is grey, with a reddish-brown line; its snout is yellowish-brown; the back of its thorax is marked with a reddish-brown line, bounded on both sides by a dusky colour; the sides and hinder-parts of its thorax are whitish-grey; its abdomen is darkish-brown on the back, and obscure reddish-brown in other parts; its legs are yellowish-brown in their upper parts, and dusky brown in their lower parts; and its wings are pale brown, with the nervures yellowish-brown, and the anterior border yellowish-brown, succeeded by an obscure whitish streak. The abdomen of the female is thickest near the middle, and tapers thence to a point at the hinder extremity; and the abdomen of the male is thickest at the hinder extremity, and has there the form of a kind of club.

"This insect," observes Mr Duncan, "is very plentiful during the summer months in all parts of the country. Its long legs are of immense advantage to it in the places it frequents, as they enable it to skip over the grass as if on stilts; and it still farther facilitates its motion while so doing, by keeping the wings expanded, to render it buoyant. The female lays a great number of eggs, which are very small in proportion to the size of the insect, and of a black colour. These she places at some depth in the earth, which she pierces for the purpose with her ovipositor. The insects may easily be seen performing this operation, and it will at once be known that they are so employed by the singular position they assume. The body is placed in a perpendicular direction, supported on the hinder feet and extremity of the abdomen, while the wings are expanded, and the anterior legs rest on the surrounding plants. When a sufficient number of eggs have been laid in one spot, the insect moves on to another, without changing the vertical posture of her body, merely dragging herself forwards by her fore-legs, aiding her movements with her wings. These tipulæ seldom fly far at a time, and it is only when the weather is somewhat calm that they venture to do so at all. Their legs are exceedingly fragile, and, when seized by them, the insect generally makes off, leaving them in the hands of the captor with an appearance of the utmost *sang-froid*."

The full-grown larva or grub has the shape of an elongated cylinder, somewhat suddenly attenuated at the ends. It has no feet, and is of a dull greyish colour. Two hooks rise from the sides of the head, and meet at their points, and seem to press any substances which the creature wishes to cut or bruise against the toothed upper surface of two scaly, convex, fixed pieces which are situated below them. Two short fleshy horns appear on the upper part of the head; and six rays of unequal size are situated at the hinder extremity, and overfold and protect the breathing-pores. The pupa somewhat resembles the chrysalis of some kinds of moth; and is nearly of the same colour as the larva, and has the edges of its segments fringed with pretty strong hairs.

The eggs of the fly are generally deposited during the latter half of August. The larvæ appear about eight or ten weeks after the eggs are laid; and if the weather be mild and humid, they make considerable progress before the arrival of winter frost. They are not killed by the severity of even the coldest winter; but remain stationary, and perhaps torpid, till spring; and, from that time till early in May, they increase in size till each becomes about an inch in length and about one-third of an inch in girth. They are exceedingly destructive, both in pastures and in corn-fields, during all the period succeeding their vernal revival; and they become increasingly so as they advance to maturity. Between the 20th of May and the middle of June, according to the state of the weather and to the degree of feeding they have had since spring, they pass into the pupa state; and if the weather be wet at the time of the transformation, they are very liable to be then killed by the moisture; but at no other time of their existence do they seem to be, in even the smallest degree, injuriously affected by the weather. The pupæ have a thin husk around them; and they lie dormant or at least harmless in this till they burst into the imago state in August.

Grubs and slugs, though often confounded with each other by farmers, are so widely different in their structure, their habits, their season of attack, their modes of mischief, and other particulars, that they ought to be thoroughly distinguished. Grubs breathe through pores, situated near their hinder extremity and protected by covering rays, and are therefore well adapted to burrow in the ground; while slugs breathe through an orifice, like a gill, near the front, and are therefore ill-adapted to burrow in the ground. Grubs feed on the tender roots of the cereal and the pasture grasses; while slugs feed on the tender leaves of these grasses. Grubs feed wholly below ground; while slugs feed chiefly, if not wholly, above ground. Grubs are usually unassailable by the weather, and at one stage of their existence are liable to be killed by moisture; while slugs cannot at any time live without moisture. Grubs never appear on the surface of the ground, at least during the day; while slugs appear on the surface at all hours in wet weather, and come out at night or during the dews in dry weather. Grubs can crawl freely, and live for a time, on dry soil; while slugs, in consequence of the slime on their body and of their constitutional habits, can crawl only on moist surfaces. Grubs begin to live in October or early in November, and do most mischief in April and May; while slugs are little larger than pin heads in the middle of February, and do not commit any material injury till June, or at least till toward the end of May. The particular slugs here referred to are the common white ones, of the species *Limax agrestis*, which are notorious for their attacks on oats, wheat, and turnips.

Grubs, or the larvæ of the crane-fly, generally burrow about one inch or two inches below the surface of the ground, and mine their way among the roots of the grasses, and cause the herbage of pastures or the seedlings of cereal plants to wither and perish from failure of nourishment. They particularly infest old grass lands, and give a special preference to such as contain some portion of peat-earth; they often work dreadful havoc in wet or ill-drained clayey or mossy pastures, where excessive evaporation causes the ground to be cold, and retards the vernal growth of the grasses; and they also commit great ravages in the first cereal crop of a rotation, either after clover or beans, or especially after the breaking up of grass land. They are often a severe scourge to farmers; and almost every year, in all parts of the country, they make their presence to be in some degree felt; and they are all the more mischievous on account of their preying upon the earliest and most tender of the grasses. They have been supposed by Reaumur and the majority of subsequent writers to feed on fine mould, and to injure the grasses only by disturbing the soil, and preventing the roots from fixing their spongioles and steadily taking up nourishment; but they have been proved by recent investigation actually to devour the roots, and they seem to possess a mechanical organism quite adapted to the purpose. Their devastations, too, are sometimes so extensive and appalling as to be ascribable to nothing short of the eating of the roots. "In the rich district of Sunk-Island, in Holderness, in the spring of 1813," say Kirby and Spence, "hundreds of acres of pastures have been entirely destroyed by them, being rendered as completely brown as if they had suffered a three months' drought, and destitute of all vegetation except a few thistles. A square foot of the dead turf being dug up, 210 grubs were counted on it; and, what furnishes a striking proof of the prolific powers of these insects, last year it was difficult to find a single one."

The destruction of grubs, while a matter of great practical interest to farmers, is unhappily a matter also of some difficulty. The catching of the perfect insects is easy; but, in consequence of their vast numbers, their general diffusion, and their very prolific powers, it can never be so extensive as to make any considerable diminution in the number of the larvæ. The saturation of the soil with some caustic fluid, which should kill the larvæ, and yet not injure the grasses, would probably be the best expedient. Heavy rolling, in the case of both pastures and broken-up lea ground, has been recommended and is frequently practised; yet, except on clay lands which are much compressed by it, and which require caution and well-timedness in the application of it in order to prevent damage from the loss of their porosity and the bruising of their grass-roots, it is very seldom if ever successful. "I have had good lea of four or five years old," said a clever practical writer in the Dumfries Herald in 1841; "I have often gone over it in spring, and attentively examined it with a magnifying glass where I knew that grubs abounded, yet I never saw one of them above ground; but when I cut the turf, I found plenty about an inch from the top. The grubs are said to come above ground at night; and it is in belief of this that farmers roll their oat-fields during night, in hope of thus killing the grubs. And they tell us that the roller becomes clagged over with the bruised grubs. It might be worth their while to ascertain whether they had not killed earth-worms and slugs instead of grubs. In young oats, I have sometimes found a grub within half an inch of the top; but I never knew a case of rolling decidedly killing the grubs to any great extent. On heavy clay soils, rolling, though it does not at once kill the grubs, will so compress the soil that the injury done by them will be greatly diminished; and, if the ground is not rolled till after the plants are fully formed above ground, vegetation would thus be allowed to advance with little injury from them. But where the soil contains light moss, rolling for grubs is utterly useless."

A good remedy, in the case of breaking up grass lands and clover leas, is early and deep ploughing. As the clover hay is removed from the land a little after midsummer, the clover stubble might be ploughed in the interval between that time and the month of August; and the grub would then have everywhere passed into the perfect fly,—and the latter, in obedience to its instinct, would refrain from depositing its eggs in the naked soil. Or when the ploughing of grass lands or clover leas does not take place till the eggs are deposited, it may be made to turn over such a furrow-slice as shall bury most of the eggs too deep, or beneath too smothering a surface to permit their being hatched into life. Or even if the ploughing should be postponed till November, or take place when the grubs are young and weak, it may bury most of them at such a depth, or beneath so well-laid a furrow-slice as will prevent them from ever rising to the top. "This," says the writer already quoted, "explains the cause of the utility of the 'furrow-presser' used in the west of Scotland. It lays the slices so closely together, that most of the grubs are smothered while tender. But if the lea-ploughing is deferred till late in the spring, when vegetation has given strength to the grubs, and then if the slices are ill laid over, a host of grubs is unavoidable. I doubt whether the advantage of winter-pasture, even on our best leas, is not more than counterbalanced by the injury done by grubs and slugs to the next oat-crop."

A remedy of considerable efficacy on heavy soils which have been late ploughed and are much infested with grubs—though a remedy both unnecessary and useless on light soils in the same predicament—is dibbling, preceded by cautious rolling. A writer in the Northern Agricultural Magazine of 1828, says, "During the last 14 years, I have invariably got rid of grubs by dibbling; and though in 1818 I had upwards of 16 acres which to all appearance were gone, so much so that my neighbours advised me to plough them up, I persevered, had an excellent crop, and sold the whole for £11 14s. per acre, while those around me who persisted in rolling during the night, sustained a total loss." The process of dibbling may be performed by women, at a cost of about 3s. or 4s. per acre, and consists in making quite smooth holes, with iron-shod potato dibbles, about 6 inches deep, and at distances from one another of about 12 or 14 inches. The grubs, we are told, fall into the dibble holes while they are moving about at night, and sometimes occur in the average of from 8 to 16 in each hole, and soon die at the bottom, and assume the appearance of a little train oil; and their fatty looking remains have been supposed to act afterwards as a somewhat powerful manure, and to render the crop which they originally threatened to destroy unusually luxuriant. Some persons treat the whole of the dibbling remedy with derision, and affect to think it too silly to deserve a moment's attention,—and probably they might be right enough if it were proposed for light porous lands, incapable of receiving such tightly compressed holes as are necessary for holding the grubs prisoners; but reflecting persons, if they have fair opportunity, will think it abundantly worthy of trial on any of the adhesive kinds of land for which it is recommended.

A sudden and favourable change of weather is occasionally successful, after artificial remedies have failed. "The ravages," says Mr. Stephens, in his Book of the Farm, "are generally committed in dry weather with an easterly wind; and when rain falls, they cease. It is surprising how a field will recover from the effects of grubbing. One season a field of mine, of fine deep hazel loam, after two years grass, was dreadfully grubbed; and after trying the usual remedies to get quit of the insects without effect, a rainy night silenced them. Most of the field appeared bare after having exhibited a beautiful braird, but on the plants acquiring renewed growth, they tillered out with great force, and almost covered the ground as thickly as desirable. At harvest the crop was a very strong one, the straw being difficult for women to cut with the common sickle; the spikes were very large and full; the stooks, when set without hood-sheaves, stood about 6 feet in height; and the yield was not less than 60 bushels to the imperial acre. On good soil I would have no fear of potato oats tillering out, after being severely grubbed, sufficiently to afford a good crop; but such a result should not be expected of common oats upon an inferior soil."

The rook, *Corvus frugilegus*, is very generally regarded—and was regarded even by Mr. Stickney, the author of published Observations on the Grub—as a great enemy to grubs, and a chief agent in picking them out of land. But though rooks may destroy a few grubs, they never make such a thinning of them as materially to lessen their ravages upon a crop. The grubs usually lie too far beneath the surface of the soil to be assailable by the rooks; and the rooks so seldom visit lea-fields in winter or spring, that their visits in these seasons are regarded by the peasantry as portents of storms. "How then," asks the writer in the Dumfries Herald, "can any maintain that they destroy grubs in winter or spring? I have felt interested," adds he, "in seeking to discover what rooks are employed about on these occasions. And therefore I have followed them to the spots where they alighted, sometimes immediately after they sat down, and at other times after they had been for some time on the ground. I found many casts of earth-worms, and sometimes several small white slugs on the surface, but no grubs; and my conclusion from these observations was, that the rooks were employed in seeking earth-worms, and perhaps small slugs. I express doubt of their eating the slugs, because I have never heard of any person who ever saw a rook take a slug in his mouth, or had any satisfactory evidence that they ever taste slugs; while on the contrary, every ploughman has an hundred times seen them devouring earth-worms. The rooks have in winter been accused of rooting up whole crops of clover. If they were then in search of grubs, their services were dearly bought. But whoever saw rooks tear up grass on old lea, where grubs chiefly abound? They have not strength enough for this. And, without tearing up the grass, they cannot get the grubs at its roots. How foolish would it be, how unlike the sagacity of rooks, to labour so hard for grubs, at a season of the year when an hundred, I may say five hundred, would scarcely be a meal to one of them, and when they can so much more easily tear up wheat plants, and get plenty of earth worms. But if the rooks do not eat grubs in winter or early spring, I am told that they take them afterwards to their nests and feed their young with them. I believe there is some little truth in this. They turn over a few of the clods after, but not before, the oats germinate on the sown fields, and below these, they find either grubs or earth-worms; but after germination it would be vain to expect many grubs under clods. By far the greater number of them are then dispersed over the soil and preying on the roots. I sowed a few acres of a five year old lea-field on 17th ult., and have often examined it since; and I aver, that during the first week after the seed was harrowed, I found many, I may say hundreds of places scraped by the rooks, exactly as the hens scrape; and from attentive inspection at different times since the oats germinated, I estimated the average number of grubs on a square foot of the sowed ground to be at least ten, and the average number which the rooks might take, by turning over the clods, one on every ten or twelve square feet of surface. It is easy to distinguish where clods have been moved after rain has fallen on the soil. The above estimate makes it impossible for the rooks to take more than one per cent. of the grubs from the germinated oats; a small compensation for the mischief done by them at all seasons! If any person doubt that so many as ten grubs may be found on a square foot, Messrs. Kirby and Spence will tell him that 210 have been found on one square foot."

GRUBBER. An implement of tillage, of intermediate character between the harrow and the plough. It has been described as "in principle a member of the harrow tribe of implements," and as "approaching so closely the harrow in its character that it is not easy to draw the line of distinction;" but—at least in all its best forms and most recent varieties—it really differs as much from the harrow as from the plough, and must be considered, as, to both its structure and its mode of action, a perfectly distinct and exceedingly important agricultural implement.

Difference between the Harrow and the Grubber.—The harrow pulverizes ploughed soil, disengages from it and collects the roots and stems of weeds, and covers the seeds of cultivated plants. The rectangular harrow is attached to the draught at only one point, and has a shaking, shying, alternating, and sometimes tossing motion, and is in consequence well suited to break the clods of dry lumpy land, and to cover broadcast-sown seeds in almost any kind of soil; for, in the former case, its teeth being constantly flung from the direct line of draught, and constantly flinging themselves back to regain the equilibrium, strike the clods upon the surface, and either break them or tear out the roots and stems which bind them together; and in the latter case, its teeth, in continually swinging and oscillating from side to side, and in seldom or never having sufficient steadiness to penetrate far into the soil, perform exactly the kind of dispersed and superficial action which buries a maximum of seeds at a desirable average of depth. The rhomboidal harrow, on the other hand, is drawn equally by two horses walking abreast, and makes a close series of parallel and comparatively deep lines of indentation through the soil, and admits, when necessary, of a certain degree of lateral motion, simply by means of shortening the posterior swingle-tree and otherwise modifying the attachment of the draught; and it is, therefore, peculiarly fitted, on most kinds of land, for pulverizing soils and disengaging weeds. See the article HARROW.

Every harrow, however, be its particular construction what it may, fails to bring up the roots of weeds from any considerable depth, to reduce cohesive and refractory land, to exert more than a comparatively shallow action, to perform such fallowing operations as are intermediate between upturning and cleaning, to perform a hoeing process upon land too foul for the harrow and too pulverulent for the plough, and occasionally to act as an entire succedaneum for the plough in the tillage of clean, powdery, and very light soils which do not immediately require to be thoroughly upturned. "The teeth of the harrow, being forced into the ground solely by their own weight and that of the frame-work in which they are fixed, are not well calculated to penetrate into it, and are constantly thrown out by the obstacles they encounter. In firm clays or cloddy ground, therefore, the impression made by the teeth of the harrow is often seen to be extremely superficial. Were the teeth formed somewhat like the coulter of a plough, and curved like it forward, they would better insinuate themselves into the ground, and be less liable to be forced out of it when encountered by obstacles. But the harrow, from its nature, does not admit of this construction; for in this case the teeth would form an angle with the frame-work in which they are set. The weeds and rubbish disengaged from the ground would be collected at the angle, and would thus be carried along with the harrow and impede its progress; while this form of construction would add to the difficulty of freeing the teeth from the rubbish collected."

The grand object in the invention of the grubber, therefore, was to substitute coulter-like tines for the teeth of the harrow, and to mount these within some kind of frame-work which should possess similar capacities of draught and control to those of the plough; and this object has been fully accomplished. The grubber has a heavier frame than the harrow, is mounted on wheels in the manner of wheel-ploughs, and has shafts for guiding their action, and handles for lifting the tines out of the ground at the end of the ridges; and it admits of much variety of construction to suit different soils and purposes, and sufficient graduations or control of action to adapt itself to the degrees and emergencies of any one course of tillage.

Uses of the Grubber.—The grubber, though far from being so well known and commonly appreciated as its excellence demands, has for some little time been in pretty general use in some of the best cultivated districts. It is most eminently serviceable on the lighter kinds of soils; but, when preceded by one ploughing or at the utmost two ploughings, it makes good and profitable work on even stiff loams and adhesive clays. It acts more or less as a substitute for the abundant use of the plough, and occasionally as a substitute for all use of it whatever; it prepares soils of all kinds for the most efficient action of the harrows; and it searches and tears the soil, intermediately between ploughing and harrowing, in such a manner as to produce a far higher degree of cleaning and pulverization, and at considerably less cost of time and labour, than could be effected by mere ploughing and harrowing. In any medium kind of land, in an averagely fair condition, one ploughing, one grubbing with half-set tines, one cross-grubbing with full-set tines, and a few finishing turns of the common harrow, usually constitute a very efficient tillage. A plough, too, turns over only 9 inches at each bout, while a grubber of the best construction tills a breadth of 4 feet 4 inches; one pair of horses, drawing the plough, till on an average about one acre of land in a day, while the same horses, drawing the grubber at the same pace, would till nearly six acres; any horses can move at a quicker rate with the best grubber than with the best plough,—so that a pair which could plough only one acre would grub considerably more than six acres; and land which is tilled with plough, grubber, and harrow, can, in many instances, be cleaned and sown much earlier than land of the same kind, and in the same situation, tilled only with the plough and the harrow.

The grubber is specially useful in assisting the operations of the summer-fallow. "When land is full of root-weeds, the repeated operations of the plough, the harrow, and the roller, are the methods resorted to for tilling and cleaning it; but very frequently, when the land is stiff, even the operation of ploughing itself tends to compress the furrow-slices, and if the influence of the sun be considerable, it will be formed into a hard mass, on which the subsequent operations of the harrow and the roller have little comparative influence. So much is this felt in many of the stiffer clays of England, that it is a very frequent practice to delay giving the first ploughing to the fallow land till the month of May, by which one of the great benefits of an efficient summer-fallow is lost. But, by means of a well constructed grubber, such land may be cleaned and tilled without the necessity of turning up a new surface. The instrument, too, can be made to go at any depth in the soil which may be required, and thus the land can either be stirred to the depth to which it had been originally ploughed, or to such depth as may be most suitable for the purpose intended, whether that purpose be to clean the land of root weeds, or to till the soil only a few inches deep.—Further, land which had been ridged up in autumn or winter, after having produced any of the leguminous crops, as pease or beans, may be prepared for the seed with advantage by using the grubber alone, and without the necessity of a repetition of the more costly operation of ploughing. In this manner, the seed is sown upon the surface-mould which had been pulverized by the influence of the sun and frost. In the case, too, of land which had produced a crop of turnips or potatoes, the grubber may, in all cases, obviate the necessity of a second ploughing as a preparation for the seed; and may even, in many cases where the soil is light and dry, obviate the necessity of ploughing at all after the green crop has been removed or consumed."

History of the Grubber.—An implement of a medium character between a powerful and long-toothed harrow and a modern grubber, and called urpix or irpex, was in use among the ancient Romans; and is described by Varro as a plank with teeth for pulling roots out of the ground, and as drawn by oxen in the manner of a wain. Various implements, more or less like this ancient one, and exhibiting a desiderated but slow transition from the harrow to the grubber, appear to have been known to the best class of farmers at an early period of modern British agriculture. One of these, called an edget, was in use, in the eighth decad of last century, in the vicinity of North Berwick in East Lothian; and is described as follows in an early volume of the Highland Society's Transactions, "The tines were fixed, standing perpendicular,—the feet not dipping, but forming a right angle with the tines; the wheels were only two, —these stood in front of the machine, and, being moveable upwards and downwards, regulated the depth the tines were intended to work at." But while this rude implement remained unimproved in Scotland, and continued to be very little known there in even its unimproved state, the implements corresponding to it in England advanced, stage after stage, toward the form of grubbers, till they became the groundwork for a very superior class of implements in both divisions of the island.

The scuffler, derived from the Kentish nidget, was the first decided stage of improvement. This was originally a small, heavy, triangular harrow, with tines longer than harrow-teeth, sharp, penetrating, and inclined forward, but without any plates at the bottom; and it afterwards was constructed with a number of triangular plates or feet, steeled on their edges, fixed at the bottom of tines in the form of iron bars, and looking, jointly with these tines, like the feet and legs of a duck. This implement both cut up weeds and pulverized the soil; and may even yet be usefully employed on light lands which are free from stones and have a plain surface. "Scuffling strong land, and exposing it to the sun and air," remarks Sir John Sinclair, "is greatly preferable to harrowing, which tends to consolidate the surface; but it is necessary to have the land well reduced before the implement is employed."

The scarifier was the next great stage of improvement; and this was introduced from England to Scotland in 1811, and occasioned that year to be a sort of era in the history of British tillage. The particular form of the scarifier introduced to Scotland was brought by Sir John Sinclair before the Dalkeith Farming Club, and was 4 or 5 years after figured and described in the Transactions of the Highland Society, and is now very generally called the old Scotch grubber, and the old quadrangular grubber. Its frame is wooden and rectangular, and is mounted upon four cast-metal wheels, of 20 inches in diameter. Two bars extend within the frame, and from end to end of it; nine cross-bars are mortised to these, at distances of about 8 inches from centre to centre; and a pair of handles or small shafts for guiding the machine, are attached to the third and the seventh cross-bars, so as to be at equal distances from one another and from the ends. Eleven coulters are fixed into the nine cross-bars and the two end-bars of the outer-frame; and are placed in such an alternate manner that five are near the front of the frame and six are near the back. "Around the openings for the coulters, above and below, are plates of iron for strengthening the wood, and with bolts firmly fixed to steady the coulters when the machine is at work. These bolts are attached by chains to prevent them from being lost, should they happen to drop out. By means of the bolts, the coulters can be set to any depth required. When the machine is to be removed from one field to another, the coulters in the ends of the outside frame are lifted up to the top by shifting the bolts; and the inner-frame is then lifted up by means of the handles, and is supported by small iron stays. The coulters stand inclined forward, and have steeled triangular feet, dipping a little, from 3 to 4 inches broad at the base, and from 5 to 6 inches long from the base to the point of the triangle." The wheels can be set at a higher or a lower pitch by means of the pins and the wedges, and can, in consequence, modify the depth of the implement's action, or the degree in which the coulters penetrate the ground; and when the machine is moving down a declivitous hard surface, the fore-wheels, if necessary, are dragged to prevent the machine from running against the horses. This implement, in spite of its cumbrousness, and its obvious defectiveness, was regarded by the ablest and most scientific agriculturists of the day as a very grand advance in the appliances of cultivation. "Such," said they, "is its utility, in saving ploughing, and keeping the land clear of weeds, that it is supposed to have added considerably to the value of every farm where it has been introduced; and it is considered to be one of the greatest improvements in the culture of the soil that modern times can boast of." Yet its faults are great and obvious. The very considerable dip of the feet gives it a tendency to go down into the soil, and occasions a constant pressure on the wheels to keep it from sinking, and a corresponding drag upon the draught of the horses. The triangular and spreading form of the sharp-edged feet of the coulters, too, causes a severe cutting operation upon firm ground along the path or lower stratum of the machine's action, and occasions a very great and useless expenditure of draught. The form, size, and weight of the machine also diminish its utility; and, along with the previous disadvantages, require it, in the majority of cases, to be drawn by four horses. Much inconvenience and waste of time are involved in its general working, especially at the ends of the ridges; and its large frame-work and the confined position of its coulters render it continually liable to be choked up with weeds, stubble, and rubbish, and to retain them to such a degree as to give the workman considerable trouble in clearing it again for action.

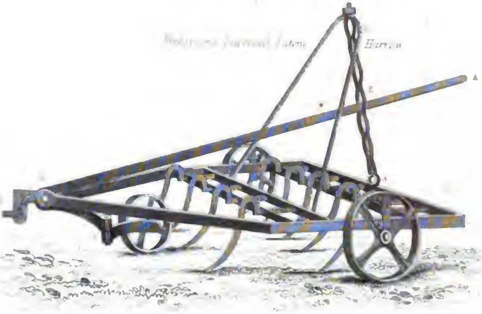
Various implements, under various names, but particularly under those of scarifiers, cultivators, and grubbers, served jointly with the old Scotch grubber, at either earlier, or contemporary, or later dates, to lead the way to the true grubbers or thoroughly modern class of improved implements. Among these might be named Parkinson's scarifier, Weir's improved cultivator, Hayward's cultivator, Beatson's grubber, Cooke's scarifier, Fuller's extirpator, and some others. But the most anomalous, and at the same time the most useful, and almost serving as the type of a quite distinct class of implements, intermediate between grubbers, harrows, and hay-tedding machines, is Morton's revolving harrow. In this machine, a number of small naves, armed with radiating prongs, are made to revolve by the progressive motion of the machine; but they revolve in planes oblique to the line of direction in which the machine travels; and they not only stir the soil, but tear out root-weeds, which, as well as surface-weeds, are immediately collected by an appended harrow. "The original machine consisted of sets of spikes or prongs, fixed on an axle, round which they revolved like the spokes of a carriage-wheel. This axle was placed oblique to the line of motion, so that the manner in which the teeth worked was of a twofold nature; they partly revolved, and they were partly dragged like the teeth of the common harrow. The axle consisted of two parts converging towards each other, forming the two equal sides of an isosceles triangle. There were ten sets of teeth in all, five being on each side or half of the axle; and each set contained ten spikes or prongs, like the spokes of a wheel, but curved forwards at the point. The machine moved on two wheels, and required the labour of four horses." But it was afterwards improved and simplified by its inventor, so as to lessen its draught; and it led to the invention of some other instruments of its own peculiar class, particularly Brite's revolving harrow and Vaux's patent revolving harrow,—the latter of which was patented in 1836, and possesses two series of revolving spikes, the one so placed as to clear away tufts and accumulations of rubbish from the other. But revolving harrows of any kind cannot be considered as true grubbers; and though excellently fitted for particular soils, situations, and purposes, do not possess such comprehensive adaptations as the true grubbers, and possibly may never come into general use.

The earliest true grubber, or next great stage of improvement after the scarifier or old Scotch grubber, was an implement brought out, about the year 1820, by Mr. John Finlayson, farmer at Kaims, in the parish of Muirkirk, in Ayrshire, and called the patent harrow or patent self-cleaning harrow. This machine was triangular-framed, and made entirely of iron, and mounted on three wheels, the foremost of which was a castor; and by means of a long lever which, in a limited degree, raised or depressed its tines, it was capable of working at different depths in the soil, and was freed from some of the disadvantages which so seriously encumbered the scarifier. It was made with either 5, 7, or 9 strong tines or coulters; and, according to the number of tines, it was drawn by 2, 4, or 6 horses. But even this machine, chiefly in consequence of its deficient means of raising the tines out of the ground, has been superseded by numerous improved grubbers,—and particularly by Finlayson's improved patent harrow, Kirkwood's grubber, and Wilkie's grubber in Scotland, and Biddell's scarifier and Lord Ducie's cultivator in England. These five implements may be regarded as, in the present state of agriculture, comprising everything worthy of attention in the category of true grubbers. The three Scotch ones present a resemblance in general form to one another and to the original patent harrow of Finlayson; and though the two English ones differ widely in structure from the Scotch ones and from each other, all the five aptly and facilely perform the various operations which we have described as proper to the true grubber's action and adaptations. Another group of implements, indeed, have a grubbing action and are frequently called drill-grubbers; but they are constructed and used only for acting chiefly between the rows of growing crops, and they will come to be described under their more appropriate name of horse-hoes. See the article HORSE-HOE. The sequel of the present article, therefore, must be wholly occupied with a notice of the five implements which we have named.

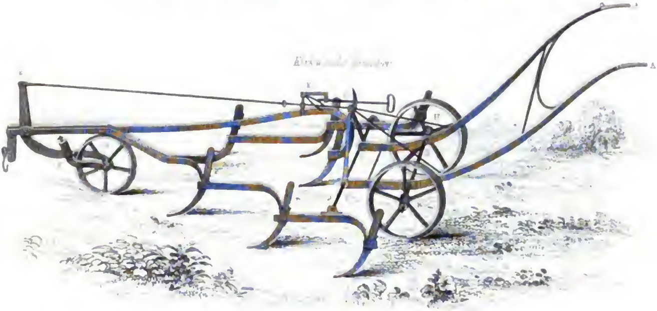
Finlayson's Improved Patent Harrow.—This machine has a different arrangement of the wheels and levers from the original patent harrow, and is, in consequence, both efficient and very commodious. The hind wheels are attached to crank levers vibrating on an axis, and are thence connected with the lever of the fore-wheel by means of a connecting-rod; and a powerful lever, acting on this combination, and adjusted in readiness to the hand of the operator, enables him to raise the entire frame and its tines promptly and completely out of the ground. Two varieties of the machine came early into use,—the one comparatively large, and requiring to be drawn by three horses on light land, and by four on heavy land,—and the other comparatively small, and requiring to be drawn by two horses on light land, and by three on heavy land; and several varieties are now made; but all, whether early or recent, have essentially one construction, and are particularly distinguished by the swan-neck or self-cleaning form of their tines.

The larger early variety is represented in *Fig.* 1, *Plate XXIV.*, and may be regarded as a good type of all the varieties. It tills a breadth of 5 feet 4 inches at one bout, and weighs between 4¼ and 4½ cwt.; and each of its tines has a length of 29 inches, a breadth of 1¼ inch, a thickness at the point of 1½ inch, and a thickness elsewhere of ⅞ of an inch. Its two sides are for some distance parallel, and are there connected by two sets of transverse bars. "Into the hindmost of these sets are inserted five double curved teeth or prongs, and into the foremost four prongs. A little before the foremost prongs, the continued sides converge, so as to meet at the point B, where they are attached by a bolt to the apparatus ADC, consisting of the handle or regulator A, the bar leading to the forewheel C, and the part D, to which the line of draught is attached; these three parts A, D, and C, being all united together. On the hindmost transverse bar is an upright lateral spring E, consisting of two rods, forming openings, supported by two rods, from the hindmost of the two foremost bars. The regulator is made to pass through these upright lateral springs. And as the regulator, the point of draught, and the bar leading to the forewheel, are all fixed together, or of one piece, it will appear that by raising the regulator (the forewheel being always on the surface), the point of draught, and consequently the forepart of the frame, will be depressed, and the prongs forced deeper into the soil. When the regulator is at the bottom of the upright lateral springs at *a*, the foremost prongs are then lifted out of the ground; and as the regulator is lifted up through each opening, the prongs descend about 1½ inch till it is up to the top at *b*, which gives the maximum depth, when the prongs will be between 8 and 9 inches in the ground. The hind part of the frame was raised or depressed by means of a screw on the axle of the hind wheels. These were put on, according to Mr. Finlayson's original plan of the instrument, at the sides behind the hindmost transverse bar. The length between the fore and hind wheels, however, was found to weaken the machine, and cause it sometimes to have a vibratory motion. To obviate these defects, Mr. Kirkwood afterwards made these machines, with the permission of the holder of the patent, with the hind-wheels as shown in the figure, placed opposite to the upper curve of the hindmost prongs. The axles, by means of a capstan attached to the side-beam, may be elevated or depressed, and thus the hinder

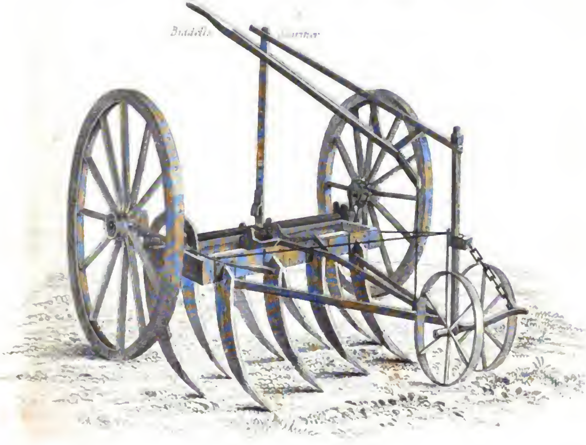
Finlayson's Improved Patent Harrow



Kirkwood's Grubber



Biddell's Scarifier



prongs made to correspond in depth with the foremost prongs."

Kirkwood's Grubber.—This machine was invented by Mr. Kirkwood, an intelligent and ingenious mechanic at Tranent, who, as already noticed, effected a considerable part of the improvement on Finlayson's patent harrow; and, in point of time, it preceded the improved form of Finlayson's implement, and was probably, in even its original form, the earliest variety of grubber which combined thorough commodiousness with great efficiency. It is distinguished by a simple and powerful combination of the levers and the connecting-rod for raising the tines out of the ground; and it permits the workman, merely by pressing his hands on its handles, to graduate and modify the depth of the tines at will, or to lift them at any moment entirely out of the soil. It speedily underwent improvements, and continues to receive modifications; and it is made of different sizes, and with either five or seven tines, to suit different soils or to be drawn by respectively two and four horses; but it does not vary in any of the essential principles of its construction, and is commodious and efficient in every one of its varieties.

In *Fig.* 2. *Plate XXIV.* is a represention of a seven-tined variety of it, which may be regarded as a good type of the whole. The tines are a kind of blunt coulters, and are so placed as to move at equal distances from one another, and parallel to the line of motion. "The frame-work rests upon three wheels, to the axle of the two posterior of which at BB, are fixed the two guiding handles AA. These handles, which are moveable round the axle at BB, are extended to the cross-bar at CC. By depressing the handles they act as levers, of which the fulcrums are BB, and elevate the bar CC, and consequently the posterior part of the frame-work. Further, the part of the machine EF, to which is attached the forewheel G, is connected by means of the rods ED, DH, and DL with the handles AA; the same depression of the handles which elevates the hinder part of the instrument, acts upon the upright rods CD, CD, which are moveable round the iron bar CC, at these points. This acting upon the bar at the points CC, moves forward the forewheel G, and thus elevates the fore part of the frame-work, and that in the same degree as the hinder part is elevated. Thus an elevation or depression of the guiding handles elevates or lowers the whole frame-work, and consequently causes the teeth to move at a greater or less depth as may be required. By means of a simple contrivance at the point K, the rod ED is fixed in its position, and thus the whole frame is kept at the elevation required. By depressing the handles sufficiently, the whole teeth may be lifted out of the ground, which is found to be extremely convenient when turning at the end of ridges, and when moving from one field to another, or even when encountering great obstacles in the ground, as stones. The various coulters being also fixed in their place by keys or wedges, may be removed, or set at a greater or less depth as may be required. The space covered by the coulters is 4 feet 4 inches. The coulters are 14½ inches long below the bars; 2 inches broad, or deep; and ¾ths of an inch thick, or across, except at the point, where they are 1¼ inch thick." The diameter of the hindmost wheels is 22 inches; and the weight of the whole implement is about 4 cwt.

Wilkie's Grubber.—This machine is the invention of the well-known ploughmaker at Uddingston. It partakes of the principles of both Finlayson's and Kirkwood's, and at the same time has characters peculiar to itself. The parallel motion by which the coulters are raised out of the ground, is produced by means of the lever only, and parallel links; and the coulter-frame itself constitutes the connecting-rod of the motion. The two sides approach each other, not in straight lines, but by a series of gradations; and the coulters are so fixed upon the gradations as to have aggregately a triangular adjustment. The coulters have, in a considerable degree, the swan-neck or self-cleaning form of those of Finlayson's; and they can be nicely regulated in the depth of their incisions, or lifted promptly and entirely out of the ground, with the same ease as those of Kirkwood's. The whole machine is elegant, effective, and convenient; but, in consequence of the elaboration of its structure, it is more expensive than its rivals, and has therefore come comparatively little into use.—All the three Scotch grubbers are always constructed of malleable iron; they are generally set on wheels of not more than 20 inches in diameter, and are therefore more or less liable to become choked when working on foul ground; they have usually either five tines or seven, and penetrate the soil to the depth of from 6 to 8 inches; and they range in price from £7 to £12, and have seldom a greater weight than 3½ cwt. when five-tined, and 5 cwt. when seven-tined.

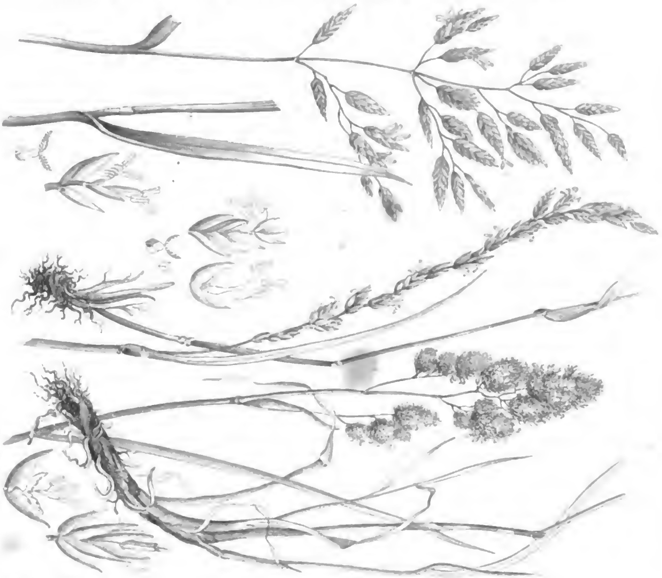
Biddell's Scarifier.—This implement is represented in *Fig.* 3, *Plate XXIV.* It was invented between 30 and 40 years ago by Arthur Biddell of Playford; and is still regarded by some good judges as the most efficient implement of its class in England. It was originally, and for a long time, made with a wooden frame and wrought-iron tines; but it is now made with a cast-iron frame; and, though a heavy implement, it has a light appearance, and possesses great facility of working. "It consists," says Mr. J. Allen Ransome, "of a very strong cast-iron frame, upon which the teeth, nine in number, are arranged in two rows, and so disposed at intervals of 16½ inches from each other, as that those in the hinder row should form a pathway midway in the intervals left by the passage of those in the front. It is suspended on a cranked axle between two wheels, 50 inches in height behind, and on an upright shaft carried on two small wheels running close together in front. It will be seen that the machine is thus suspended on three points; and by means of two levers, the one to direct the position of the front teeth, and the other to regulate the depth of the hinder ones, it may be balanced between these points in any direction that may be required. It may thus be used either with the fore-tines parallel with the hinder ones, or at a greater or less depression. This arrangement allows it to penetrate very strong or hard land, and to retain its hold when scarcely any other implement would produce any effect, and even when the plough could not work to advantage. By a simple contrivance to shift the bearing of the frame upon the axle, either side of the machine may be depressed—so that the tines shall penetrate the land to a uniform depth, even when, from the circumstance of one wheel having its path along the furrow, the bottom of the wheels may not be parallel with the general level of the land. The tines are prepared to fit case-hardened cast-iron points, of one, two, or three inches width, or cast-iron or steel hoes of nine inches width. With these latter, every part of the land will be cut. They are readily taken off and exchanged." Mr. Ransome afterwards quotes a disparaging comparison of it with Lord Ducie's cultivator, in the Prize Essay on Agricultural Mechanics, in the Journal of the Royal Agricultural Society of England, and examines some objections which are there adduced against it,—particularly, that it is a clumsy implement, that the apparatus for adjusting its tines is complicated, that the form of its tines is not good, that, in consequence of being made of cast-iron, it is liable to break, and that, when made at a width of 4½ feet, it requires to be drawn by four horses; and he so disposes of both the comparison and the objection as to give Biddell's scarifier a decided preference.

Lord Ducie's Cultivator.—This grubber was brought out a number of years ago by the talented manager of Lord Ducie's model farm; and is often called the Uley cultivator from the locality of its origin. A representation of it, as presented by Lord Ducie to the Highland and Agricultural Society of Scotland, is given in *Fig.* 1, *Plate XXV.*; and a description of it, with references to the original of that representation, occurs, in the following terms, in the 14th vol. of the Society's Transactions.

"It consists, first, of a frame AA of cast-iron, of an irregular pentagonal shape, and formed in one entire casting. This frame carries five tines, BB, &c., with which the machine is armed. These tines consist each of two parts, the body B also of cast-iron fixed immoveably into the frame by means of tenon and key, and of the point or share C fitting upon the lower extremity of the body like a ploughshare. Two forms of share are employed, the webbed and the pointed. The frame thus constructed is mounted on two wheels DD, 3 feet 2 inches diameter, and what may be called a double wheel EE in front, 1½ foot diameter. These last wheels are mounted on a reverse T-form axle, and the hind-wheels on a cranked axle F. The draft-shakle, to which the horses are yoked, is applied in a permanent position to the stem H of the T-axle; and by this means, the wheels, the stem, and the shakle turn together, forming an efficient castor-wheel. The stem H of this axle passes also vertically through an eye in the anterior angle of the tine-frame. For the purpose of elevating or depressing the tine-frame, a lever II, having equal arms, and of the second order, has its fulcrum in the top of the stem of the T-axle at I. The point of resistance of the lever is jointed to a slender pillar K fixed in the tine-frame. On the cranked axle is fixed a wheel or segment of a wheel with oblique teeth, fitted to work in an endless screw or worm L; and on the axle of the latter is the winch-handle M. The oblique-toothed wheel carries also a crank-pin, forming a lever, which is placed diametrically opposite, and of equal radius with the cranks of the main axle, each being 6 inches. The crank-pin of the oblique wheel is now connected with the power end of the principal lever, by means of the connecting-rod N; and this elegant mechanical combination has the effect of moving the tine-frame always parallel to the horizon in its vertical movements out of or into the soil, these movements being performed by turning the winch-handle M."

This machine has a sufficient height of wheels to escape the risks of choking to which the Scotch grubbers are subject; and possesses such a recurvature in the upper part of its tines as to give them the property of self-cleaning; and it admits of being made of different sizes, in adaptation to different situations and to different powers of draught. It was supposed, in the Highland Society's account of it in 1842, to be essentially so ponderous that a five-tined variety would weigh not less than 10 cwt.; but it was early furnished from Uley at an ordinary weight of about 6 cwt.; and it has since undergone improvements which affect some points of its strength and construction, and considerably increase its commodiousness and adaptations. Clyburn's five-tined Uley cultivator covers a space of 40 inches; his seven-tined one covers a space of 56 inches; and both are improved in constructing the tines so that they can be made of malleable iron, in fixing them more strongly into the frame, and in forming them with such a concavity below that they wear a sharp edge and readily enter very hard ground. "The frame is made to receive five or seven tines, each tine covering a space of 8 inches and so arranged that, although drawing lines only 8 inches apart, they are two feet from each other; and this, with their curved shape and length, prevents its clogging in the foulest land. There are three sorts of points,—

XXIV

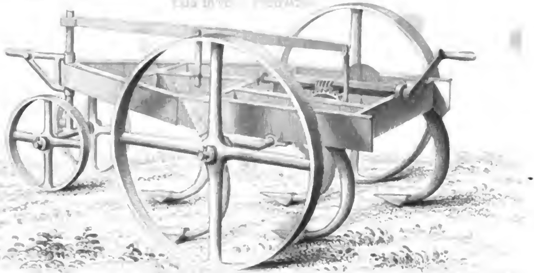


FESTUCA ELATIOR

LOLIUM PERENNE

DACTYLIS GLOMERATA

OCTOBER



XXV

one two inches wide, for grubbing up or breaking land,—another 9 inches wide, for working stubble,—the third set with steel blades, for paring *instead* of the breast-plough; and these points all fit the tines without pins to hold them. The tines are fastened into the frame with a split-key and cotter; and, in case of breaking, they can be taken out, and others put in, as easily as the coulter of a plough." A dial-plate, marked in inches, is attached to the right side of the machine, to indicate the depth at which the points of the tines are in the ground; and one rotation of the handle attached to the leverage raises or depresses the tines one inch,—a rotation to the right raising them, and a rotation to the left depressing them.—*Transactions of the Highland Society.—Sir John Sinclair's Code of Agriculture.—Low's Elements of Agriculture.—Quarterly Journal of Agriculture.—Journal of the Royal Agricultural Society of England.—Gray's Implements of Husbandry.—Ransome's Implements of Agriculture.—Annual Register of Agricultural Implements.—Catalogue of the Highland Society's Museum.—Stephens' Book of the Farm.*

GRUBBING. See Grubber.

GRUEL. Common oatmeal gruel is often of great service in severe and debilitating diseases of cattle. Many a cow, when rapidly sinking into exhaustion from disease, and after resolutely refusing to eat any proper kind of food which could be offered to her, has been restored to comparative strength, and brought within the limits of speedy recovery, simply by having gruel poured into her from time to time with the horn. But the gruel ought, in general, to be quite simple, and should never, except in extreme cases, contain any mixture of aromatics.

GRUNTER. See Broken-Wind.

GUACO,—botanically *Mikania Guaco.* A tropical, medicinal, evergreen, twining plant, of the eupatorium division of the composite order. It naturally grows about 6 feet high, secretes a profusion of juice, and carries white-coloured flowers in autumn; and it was introduced to Britain, about 24 years ago, from South America. It is celebrated, in its native regions, as a remedy for the poison of serpents, and for hydrophobia, rheumatism, gout, and other diseases; and Sir Robert Ker Porter, when residing at Caraccas, sent large quantities of it, at his own expense, to Britain, in the hope of its proving a valuable addition to our materia medica.

GUAIACUM. A genus of evergreen, ligneous, tropical plants, of the bean-caper tribe. The officinal species or lignum-vitæ tree, *G. officinale,* is a tree of the West Indies and of the tropical parts of continental America, and was introduced to British hothouses toward the close of the 17th century. The stem naturally attains a height of about 40 feet, and a girth of 4 or 5 feet; the branches are numerous and knotted; the bark of the stem is dark grey, but greenishly or purplishly speckled, and that of the branches is ash-coloured and fissured; the leaves are briefly pinnate, and consist each of two or three pairs of leaflets; the leaflets have scarcely any footstalks, and are obovate, dark-green, and shining; the flowers grow in umbel-like groups, on footstalks, from the forkings of the younger branches, and have a beautiful blue colour, and bloom from July till September; and the fruit is a five-celled capsule, with solitary and cornered seeds. Both the wood and the resin of this tree have long been used in medicine, and make a figure in the pharmacopœias, but have for some time been diminishing in reputation. The wood is one-third heavier than water, and is very hard, inodorous, bitterish, and subacrid. The resin is usually but improperly called a gum; and has a resinous appearance, a greenish-brown colour externally, a mixture of colours internally, and a heating action upon the throat when swallowed. Both the wood and the resin are diaphoretic, purgative, diuretic, and stimulating; and are used, in various modes of exhibition, for chronic rheumatism, cutaneous affections, scrofula of the membranes, and some kindred or similar diseases.—Two other species, the woody and the vertical, the former a tree of 30 or 35 feet in height, and the latter a pretty, blue-flowered shrub, of 8 or 9 feet in height, have been introduced from the West Indies within the last 40 years.

GUANACO. See Alpaca.

GUANO. The accumulated droppings of fowls, particularly of marine raptores, modified by the action of the weather, and somewhat diluted and altered by natural intermixture with alluvial substances. It was long and extensively used as a manure in Peru, and has of late years been imported in large quantities, as a valuable manure, into Great Britain. In the prevailing native language of Peru, the word *huana*, signifies dung or manure, *huanucaci* signifies the application of manure to land, and *huanaes* signifies birds which supply dung of a kind and in quantities fitted to be used as manure; and the first of these words, though pronounced *whana* by the Peruvians, has been transmuted by the guttural enunciation of Europeans, into the word guano.

Physical History of Guano.—The deposits of guano longest and best known, and for some time supposed to be the only ones in the world, occur on the islands and sea-board of Peru, between the 13th and the 21st degrees of south latitude. They exist in limited and irregular patches and masses, and have sometimes a thickness of 50 or 60 feet, and are excavated, in the course of commerce, like mines of iron-ochre. They comprise many varieties, as to both the comparative age of the accumulations, and the degree and manner in which they have been modified by natural chemical action and by alluvial intermixture; but, in general, they are popularly classified into merely three kinds,—the white, the dark-grey, and the red. The white continues to be deposited, and may readily be observed in a quite recent state in the localities which are at present frequented by vast flocks of flamingoes, cormorants, cranes, and other sea-fowl; it has been collected on the isles of Islay and Jesus, at the rate of 20 or 25 tons in a single season; and it may be observed, in the island of Torrecilla, and probably in other places, to be gradually passing into the red variety. Some of the ancient deposits, made in exposed situations, and while they themselves continued to be in a half-liquid state, seem to have been annually, or perhaps oftener, washed down by heavy rains along the skirts of declivities and into the bottoms of adjacent hollows, where no flocks of birds resorted to continue and modernize the accumulations; and these deposits, besides being much deteriorated by the chemical action of air and water during the process of their descent to the lower grounds, became so mixed with silicious sand and other earthy matters as to assume a half-mineral character, and, in some instances they lie in hollows to the thickness of 50 or 60 feet, and are so excessively indurated as to resist disintegration as sturdily as many a rock, and to require the operations of blasting and the pick-axe. The guano of these mineralized deposits is obviously a very different manurial agent from the recently fallen excrement, or even from very old guano which lies where it fell, and is altered only by the surface action of the weather, and not washed into commixation with alluvium. Some of the guano of commerce, also, though obtained from the very localities on which it was originally deposited, and where the topmost layers of it were quite or comparatively recent, has been so scraped up from the ground after all the real guano was removed as to consist substantially of mere mineral matters impregnated with fluid impercolations from the superincumbent excrements; and this has, in some instances, been hastily pronounced by the unskilled and deceived purchasers of it, a spurious and home-made manufacture of adulterating dealers.

The great thickness and vast aggregate extent of the deposits of guano may seem to warrant a doubt as to their origin in the mere excrementation of birds. The Peruvians, under the government of the Incas, knew well the fact of their origin, and highly appreciated their economical value for the national agriculture; and they made the killing of the young birds on the guano islands a capital offence, and appointed an overseer to the charge of each island, and apportioned the several islands, for manuring purposes, to definite, adjacent, and respective districts of the mainland throughout an extent of 200 leagues of coast. But when the Spaniards entered the country, they, for a time, regarded the whole of the Peruvian account of the guano as a fable, and seemed to regard the accumulations of the manure as far too vast to have possibly arisen from the excrementation of birds; and modern visitors to Peru, who should look only to the most superficial appearances, will find that the immense flocks of birds which formerly frequented these shores have been disturbed or driven away by the increase of traffic, and may possibly regard the smallness of the existing flocks as a conclusive proof that the guano must have had some other origin. Many things, however, afford decisive evidence that the main part of all good guano consists entirely of the excrements of birds,—particularly the observation and testimony of the ancient Peruvians, the observed formation of white guano in some places at the present day, the occurrence of the feathers and bones of birds in recent specimens of guano, and the close similarity of the chemical constitution of guano to that of the newly-fallen excrement of most birds, and especially to that of the raptorial sea-fowls of Europe.

The guano-birds feed on molluscs, crustacea, and numerous kinds of fishes, and not only constitute immense flocks, but belong to multitudes of species, and probably have been accumulating guano ever since the time of the general deluge. "Approaching the Bolivian coast, a little before I arrived at Cobija," says M. Alcide D'Orbigny, the eminent naturalist who, in the service of the Directors of the Paris Museum, spent the seven years preceding 1833 in exploring the north-western parts of South America, "I noticed that all the rocky points sufficiently high not to be exposed to the inroads of the sea were tinged with white,—a colour which the tops of the headlands along the coast equally bore." And after stating that the white coat of all these upper parts of the sea-board consists of "the ordure of birds known in the country by the name of guano," he adds: "It would be difficult to explain the nature of accumulations so considerable as these by the ordinary quantity of birds which we are in the habit of seeing upon our own shores; but in America this is not the case. There the great number of uninhabited points enables the feathered tribes to roost and nestle in peace, at the same time that this sea, in a virgin state as regards fishing, and perhaps abounding in the finny race more than any other in the world, furnishes them with the easy means of obtaining a subsistence. Hence it follows that these animals are there so numerous, that, at certain seasons, their various tribes actually darken the air as the flocks move along. All these marine birds, in consequence of their invariably reposing in large societies on the same points, and there passing the night, unceasingly augment the strata of guano." And he afterwards describes a particular scene which he witnessed in front of Arica, and which incidently illustrates the characteristic portions of the whole history of the guano-birds. "At a distance out at sea," says he, "where no doubt a shoal of little anchovies or of some other fish had been discovered, clouds of birds obscured the spot, eagerly clinging to it. Over the surface black gulls skimmed the air, and alternately dived. A little further on flocks of gannets and cormorants, mixed with enormous pelicans, carried on other gambles. Nothing could be more curious than to see these winged phalanxes, some hovering seven or eight metres above the sea, while others, folding up their wings, let themselves fall almost perpendicularly, and with the head foremost, upon the fish, which they pursued swimming, causing the water to splash up around them. With difficulty they emerge, holding their prey in the bill, and some minutes afterwards make another plunge. One would almost imagine, that they were engaged in some extremely animated game, enlivened by a thousand screams, although merely availing themselves of an annual migration in order to secure a meal. For a long time I kept my eyes steadfastly fixed upon this amusing fishing, when at length the parties engaged in it, having satisfied their appetites, separated in families, and winged their way to various points along the coast. The grave pelicans—the giants of the party—sought repose on the rocks projecting into the sea, where, soon becoming immoveable, their neck upright and the bill lodged on the breast, with a stupid, and almost ridiculous appearance, they quietly awaited the progress of digestion. Among the other species, the gannets and cormorants imitated their example, actually coming and placing themselves immediately below the spot upon which I stood, at all elevations upon the projecting crags of the Morro, which they daily blanched with their droppings, while the flocks of gulls, still more numerous, took a southern direction, in order to seek out some rock, the possession of which would not be disputed with them by any of the stronger inhabitants of the air. These performances regularly took place every morning and evening. At first we see these birds separately skimming the vast extent of the ocean, in order to seek out the shoals of fishes as they move along. Suddenly one of them stops, hovers for a few moments, and then plunges If the same bird successively goes through the same evolutions twice, the attention of the other explorers becomes attracted, and, ere long, they are seen assembled on the same spot, when the general fishery commences. It is these innumerable flock of birds, which, as I have already stated, deposit the thick layers of guano, fetched away from these islands as a manure indispensably necessary to the fertility of the Peruvian soil."

The particular Peruvian deposits of guano which have eventually become best known in Britain, are those of the island of Iquique, the hill of Pica, and the island of Chincha; and a brief notice of these will convey a sufficiently full idea of the aggregate existing condition of the whole guano territory. "The red and the dark-grey guano," said Winterfeldt, in 1841, "are met with in the Isles of Chincha near Pisco, at Iquique, and on the hill of Pica. The term 'guano of Iquique' is sometimes used from its having been first procured from the island of that name. This island is situated about 400 yards from the port of Iquique. It is about half a mile long, and about 200 yards broad, and furnished large quantities of guano for 25 years, when it became exhausted. The hill of Pica is very high, and is covered with guano down to the water's edge; while that side which does not face the sea is of sand and gravel. In this hill or rock I am informed that a silver-mine was formerly worked, but that no trace of guano was found during the excavation. The adjoining hills on either side are of sand, which is carried by the winds, and covers up the guano; to remove which the sand is first taken away, and deep excavations are made; the guano extending nearly a quarter of a league in length, and 300 yards in depth,"—not surely in the thickness of the deposit, but merely in the breadth of its superficies. "The Chincha Islands, which afford the best guano," says Dr. Ure, "are three in number, and lie in one line from north to south, about half a mile apart. Each island is from 5 to 6 miles in circumference, and consists of granite covered with guano in some places to a height of 200 feet, in successive horizontal strata, each stratum being from 3 to 10 inches thick, and varying in colour, from light to dark-brown. No earthy matter whatever is mixed with this vast mass of excrement. At Mr. Bland's visit to these islands in 1842, he observed a perpendicular surface of upwards of 100 feet of perfectly uniform aspect from top to bottom. In some parts of these islands, however, the deposit does not exceed 3 or 4 feet in thickness. In several places where the surface of the guano is 100 feet or more above the level of the sea, it is strewed here and there with masses of granite, like those from the Alpine mountains, which are met on the slopes of the Jura chain. These seem to indicate an ancient formation for the guano, and terraqueous convulsions since that period. No such granite masses are found embedded within the guano, but only skeletons of birds."

Other aquatic birds besides the perennial sea-birds have played a conspicuous part in the accumulating of guano. Immense numbers of various kinds of aquatic birds are summer-frequenters of the vast and numerous lakes which lie dispersed through Upper Peru; and when these great sheets of water fail in their scanty supplies of fish, or when the annual season approaches for their becoming frozen, the birds migrate to the coast to seek their food in the marine waters, and may be seen for days together descending in vast tribes or family-flocks by various routes across the mountains and the sea-board. When about to undertake the migration, they assemble in large parties early in the morning; and when they approach the highest ridges of the Sierra which prevent them from moving straight forward, they ascend spirally in numberless evolutions and gyrations till they attain a sufficient height, and then they sail over the loftiest peaks, and appear on the seaward side like dark clouds in the atmosphere; and after they have fed on the sea-shore during winter, and assisted the true sea-birds during that period to augment the deposits of guano, they return, at the beginning of summer, to their inland haunts, upon the lakes. These migratory birds include the curlew, the plover, the crane, the heron, and a number of other species of grallatores or waders. The principal sea-tribes among the multitudes of guano-birds are the family of the brachypteræ or divers, who pursue their prey beneath the surface of the water,—the fish-eating species of the anatiæ, or geese and swans,—gulls, terns, skimmers, petrels, the gigantic and powerful albatross, and other longipennæ or vultures of the sea,—and especially ducks, darters, tropical phaetons, gannets, frigate-birds, cormorants, pelicans, and other palmipedes or web-footed birds. Considerably the most productive of these groups of guano-birds is the last, the palmipedes; and the most important genera of this group are the gannets, the cormorants, and the pelicans; and the most numerous species of the gannets is the *Sula candida* or booby.

A rough estimate has been made by Mr. William Walton of the rate at which guano continues to be deposited in Peru. He assumes that the gannets, the cormorants, and the pelicans, concerned in making the deposits, each amount to a million; he alleges this assumption to be a sober estimate, both because credible witnesses have spoken largely of the great numbers of the birds, and because fully a million of carcases of seals were estimated by traders to have been recently thrown in one year on Seal, Penguin, and Possession Islands; and, supposing that each bird, on the average, voids one ounce weight in the course of each night, he finds that the yearly amount of guano deposited by these three genera of birds can be no less than 32,850 tons. He reminds us, however, that great waste occurs during high tides and boisterous weather, that much waste and deterioration are caused by the occasional falls of heavy rains, and that "in the formation of the deposits, there is some subdivision, as the birds of one species do not all roost upon the same spot, although they abstain from mixing with other tribes." But be the amount of waste what it may, it can scarcely be estimated at more than the amount of guano derived from all the other birds than the three principal species of palmipedes. The total annual deposit in Peru, therefore, even after allowing for waste by tides and weather, may be assumed, on Mr. Walton's data, at upwards of 30,000 tons. Much of the quantity deposited, however, falls on places whence it cannot be gathered for importation or even for local use; a large proportion of all the recently fallen excrement passes slowly off in an aeriform condition, while the remainder is consolidated into the compact guano of commerce; and not less than from five-sixths to nine-tenths of all the organic matter is lost, while the newest white guano passes into ancient red guano. So enormous are the gaseous escapes from the fresh deposits as to pollute the whole circumambient air, and fill it with abominable and unhealthy effluvia. "The insupportable smell of the ordure of this immense number of birds," said Feuillée in 1714, in reference to Arica, "greatly contributes to the sickness experienced in the town; and hence the inhabitants are generally in an unhealthy state, have a yellow tinge of countenance, and live in a state of languor. Foreigners, unaccustomed to this bad smell, are afflicted with unusual headaches." Yet, in spite of constant and great loss from evaporation, the continual accumulation was formerly so vast as to afford stated supplies for the agricultural uses of the whole coast, and leave the original quantity unreduced. "With the heat of the sun," said Ulloa in his Voyages, "these deposits are formed into a kind of crust, which is daily increased; and as the quantity collected is so extremely great, it does not become exhausted, notwithstanding they are constantly carrying it away, because in a short time the depôts are regularly replenished."

A very common statement hastily made by scientific men, and interestedly echoed by commercial men, is, that guano can accumulate only in the very peculiar climate of Peru, or of a place of precisely similar physical character to Peru; and the statement is usually accompanied by the assertion that Peru has no rain,—and that if it had rain, it would have no guano. "It is the dryness of the climate," say they, "which has permitted the guano to accumulate on these coasts. A single day of English rain would dissolve out and carry into the sea a considerable portion of one of the largest accumulations; and a single year of English weather would cause many of them entirely to disappear." Yet, though D'Orbigny and other highly respectable travellers assert that it never rains in the lower part of Peru, both they, and all theorists, and commercial speculators who follow their authority, are seriously mistaken. "With a powerful sun, blazing almost vertically," remarks Mr. Walton, "it will readily be imagined that the evaporation from the wide and smooth expanse of the Pacific, as well as from the luxuriant valleys bordering upon one side of it, must be enormous, and the collection of vapours in the upper regions of the atmosphere consequently in the same proportions, which, when they have attained a specific gravity, necessarily must descend. That it seldom rains in the maritime valleys, while on the mountains, only ten or twelve leagues distant, torrents frequently fall, is a fact on all hands acknowledged, and the causes of this phenomenon have been made the especial study of several distinguished naturalists. Among these, Dr. Unanue unquestionably had the best opportunity of observing, for a series of years, the peculiarities remarkable in the climate of his native land; and in his interesting little work, he accounts for the singularity alluded to in this manner. The atmosphere round Lima,—and this is a fair specimen of the upper coast,—he tells us is opaque, nebulous, and little renovated; and this part of the country being surrounded by lofty mountains to the north, the gentle winds, prevailing from the west in the morning, and the south in the evening, bring the vapours from the offing over the longitudinal valleys, where they frequently rest in mid-air, like a kind of awning. Then it is that the *garua*, a copious dew, falls; but if the winds are more than usually powerful, the vapours are carried rapidly onwards towards the mountains, where, condensed by the cold, deluging rains follow. This is the ordinary state of the atmosphere along the Peruvian shore throughout the year; but exceptions are occasionally noticed. If the maritime evaporations have been unusually great, and the accumulations in the air are too dense and too heavy to be wafted across, sudden showers descend along the coast, as well as on the contiguous islands. Of these accidental changes in the weather, some remarkable instances are recorded. Dr. Unanue, alluding to this subject, speaks thus:—'In summer, it sometimes happens that it rains at five in the afternoon; but then it is a heavy rain, and lasts only for a short time. In the years 1701, 1720, 1728, and 1791, it however rained so copiously along the coast and in the valleys during the summer nights, that many serious injuries were experienced.' The guano-yielding islands and promontories of Peru are not, therefore, so exclusively situated in rainless latitudes as is generally believed. There can be no gainsaying the authority here adduced upon this point; indeed, from my own inquiries among competent persons, natives as well as foreigners, I do not hesitate to say that it is fully borne out. When the peculiar locality, as well as the abundant exhalations from the neighbouring ocean are considered, heavy discharges from clouds, which are not always under the control of the winds, will be thought a natural consequence, although, owing to the seclusion of the situations, these occurrences have not been so carefully noticed as elsewhere."

Multitudes of accumulations of guano, therefore, similar in character to those of Peru, though generally far smaller in aggregate extent, may be supposed to exist in other parts of the world, where the climate is somewhat different; and multitudes of accumulations also, of a character more or less dissimilar to those of Peru, but still of great value to agriculture, may be supposed to exist in places where the average temperature is far lower, and the aggregate annual fall of rain is copious, as throughout the average of Europe, or even as throughout the average of the sea-girt islands of Great Britain and Ireland. Many of the drier parts of both western and eastern Africa seem exactly so situated as to contain guano of closely similar nature to that of Peru; many of the unexplored or ill-explored islands of the Pacific Ocean seem likely to contain large quantities of not much different nature; and thousands of caves, crevices, and other rocky recesses in even the unpromising parts of the iron-bound coasts of Europe are probably rich in at least such portions of guano as consist of fixed or insoluble phosphates, and as require only an accompaniment of common liquid manure to possess a compound of chemical agencies strictly akin to those of the best and most recent guano of Peru. "Considering the insoluble phosphates as not the least important of the ingredients of guano," says Dr. Davy, "the excrements of birds, wherever they have been accumulated, whether abounding in nitrogenous compounds, as in dry climates, or in the insoluble phosphates, as in rainy climates, must be valuable to the agriculturist, and are likely to repay the enterprising merchant who may import them. In the arctic and antarctic regions of the ocean, and those bordering on them, as birds feeding on fish there abound, it is probable that great stores of guano of the latter kind are laid up in accessible situations, and which may furnish cargoes to our whalers, and partly remunerate them when unsuccessful in their fishing enterprise. And nearer home, as in Iceland, the Feroe Islands, and St. Kilda, it is likely much useful guano might be collected, were the inhabitants, who depend chiefly for their support on the feathered race, to collect the excrement at the same time that they take the birds or their eggs."

Some nitrogenous guano deposits, of great value, and now nearly as well known in Britain as those of Peru, have of late years been discovered on some secluded points of the south-west coast of Africa, and especially on the island of Ichaboe, situated in 26.25 south latitude, and 14.16 east longitude. This islet is an egg-shaped barren rock, about 1,200 yards in circumference, and about 3 miles from the mainland; and in consequence of its rich coating of guano, it was soon called Guano Island. The guano deposit upon it, as it existed at the time of discovery, commenced about 6 feet above high-water mark, and gradually rose according to the configuration of the ground; it rested upon the rocky surface, and varied in depth from 6 to 40 feet; and it is supposed to have consisted principally of the excrement of the seal, the gannet, and the penguin, but specially of the last of these, and to have been superior in intrinsic manurial power to the guano of Peru. The accumulations of this deposit, like those of the Peruvian deposits, must have been in progress for ages, and liable to many contingencies of climate and weather. "Our knowledge of the spot, indeed, is so very recent, that the changes in the seasons have not yet been properly observed; but, from the contiguity of the sea, and natural atmospheric causes, it can scarcely be thought that rain does not fall there at some time or other in the course of the year." The sand-squalls, too, which occur in the adjacent regions, and which usually are both sudden and violent, and which have been known to make a deposit of sand on the deck of a vessel ten leagues out at sea, may possibly have played a powerful part in consolidating the accumulations, and in arresting them from being washed away by the rains. Within six or eight months of the news of the discovery of the island, about 100 vessels went out to it, and, in spite of the utter absence of a harbour and of great difficulties of lading, are computed to have brought away about one-third of the total deposit.

A cave, containing a large deposit of guano, was recently discovered in Jamaica, and is supposed to indicate the existence of similar ones in the same island. The entrance to it is surmounted by massive piles of disrupted rocks, which present a picturesque appearance, and seem to have been thrown together in a violent, abrupt, and convulsive manner, as if by an earthquake; the descent is easy; and the interior has a considerable extent, and is bedded to the depth of several feet with a peculiar earthy-looking substance, which proves on examination to consist principally of the excrement of birds, and which seems, from its mechanical condition and chemical constitution, to have been in the course of deposition from a very remote period,—probably from a time very soon after the general deluge. "By some persons on the spot," says Mr. Walton, "this earth is thought to be the leavings of swallows, whose dung, as they live on insects and vegetables, would no doubt be found of a rich and stimulating quality; but I am inclined to think that this accumulation, avowedly the work of gone-by ages, may safely be attributed to a larger species of the feathered race. When the Antilles were discovered, they contained various carnivorous birds, such as are accustomed to roost in caverns, and which, as the surface of the land became uncovered and the population increased, either wholly disappeared or are now only to be seen in the secluded recesses of the mountains. To birds of this class it is more probable that the rocky receptacle in question once served as a breeding-place, although at present chiefly frequented by swallows."

Unexplored caverns, of a kind likely to have long ago been the resort of vast flocks of birds, are known to exist in St. Domingo. Birds are there much more numerous than in Jamaica; wild pigeons, in particular, abounded, at a former period, in every part of the island; and immense flocks of them still exist in the east end, and make great excrementitious deposits at the places where they roost.—Some cliffs and rocky escarpments among the mountains in the north of Spain, also, are known to have been frequented for ages by enormous numbers of vultures, and may be supposed to possess large accumulations of their guano or highly nitrogenous and phosphatic excrements.—Near Dima, too, is a vast dark cavern called the cave of Balsola, which contains much guano of a peculiar character, and possibly is but an individual of a whole class of similar places, in various parts of the coasts of Europe. "This Avernean cavern," says a recent visitor of it, "which more properly might be called a perforation through the side of a hill, extending to full three quarters of a mile, is inhabited by ravens, myriads of which, as voices are heard and lights perceived within, issue from the crevices and crags, and, flying about, or perching on some projecting point, keep up such a hideous and deafening din, that for a moment the stoutest heart would quake; and yet these were only the old and disabled birds, accustomed to this home, or those sitting on their eggs, the younger broods being all out on a cruise, and no probability of their returning till nightfall. As it were to add to the effect, many thousands of enormous bats, resembling vampires, and their eyes glistening with a vivid brightness, were hanging in clusters from the roof, one by the other, like bunches of grapes under a vine-avenue, or fluttering their leathern wings about your ears. For ages, unmolested, those two races of winged animals have found a breeding-place within this cavern; and the accumulation of their dung is denoted, not only by the nature of the ground, but also by the fœtid smell prevailing in the recess."

A small quantity of guano was recently discovered in the turrets of the cathedral of Notre Dame at Paris, and is known to have been accumulated from the droppings of crows, pigeons, owls, and some smaller birds, since the reconstruction of the edifice in the 12th century; and though this of itself was a mere curiosity, it possessed much economical importance as an indication of how very near their own doors British farmers and British merchants may expect to find considerable supplies of guano. A large deposit of guano, consisting principally of pigeons' dung, exists in the limestone crags of Scarborough Head in Yorkshire; and is constantly carried away, to the amount of about 40 tons a-year, by the men who follow the perilous occupation of gathering eggs on the cliffs, and is sold to the farmers in the neighbourhood at the rate of about 2s. 6d. per cwt., and has been used from time immemorial, in the proportion of about 6 cwt. per acre, as a suitable and highly approved manure for grain crops. Another deposit, consisting principally of the excrements of cormorants, gulls, and garrots, and estimated to amount to about 200 tons in weight, is known to occur on the Little Pentland Skerries, in the Pentland Firth. And though very few of the many minor deposits which are supposed to exist in the fissured and cavernous and other comparatively protected portions of our high and rocky shores, may be as large as those of Scarborough and the Skerries, a great number of them can scarcely fail to be considerable enough to challenge the eager attention of the natives in their vicinity, and even of our great agricultural societies. "It seems to us extremely probable," observes a writer in a recent number of the Quarterly Journal of Agriculture, "that if any of our agriculturists were to offer a reasonable sum per cwt. for the dung of sea-birds, and to take proper means to make this known to the inhabitants of the northern coasts and remote western islands of Scotland, they would ere long obtain a considerable supply. At certain seasons, the natives might employ themselves in collecting it, when they can scarcely be engaged in any other profitable occupation." Guano, of a quality alleged to be equal to that of Africa or to the best of Peru, is now imported into British North America from the coast of Labrador.

Economical History of Guano.—The Peruvians are known to have commonly manured their arid arenaceous lands near the coast with guano, so far back as the 12th century; and, from the systematic, elaborate, and efficient manner in which they combined this practice with that of irrigation, they probably merit the reputation of having been the most successful agriculturists in the world during the latter part of the middle ages of the Christian era. Their lands consist principally of white sand and clay, and are remarkable for their naturally sterile and desert character; and yet, by means partly of irrigating and chiefly of guanoizing, they were made to yield abundant crops of grain, and to support a teeming population. Acosta, the earliest historian who records the practice, says, "To these islands," situated off the coast, and covered with a continuous heap of the excrement of sea-fowls, "vessels go solely for the purpose of loading this dung; for nothing else is to be obtained there; and so great is its efficacy, that the land manured with it produces a much larger crop of grain, and also an increased quantity of fruit. This dung is called guano, from which Lunaguano, in the Peruvian valleys, takes its name, the guano being there very generally used. Quinces, pomegranates, and other fruits in that place excel those of other places, in at once size, flavour, and beauty; and they owe their superiority to the circumstance of the trees receiving moisture from water which has passed through lands served with guano."

Wheat was introduced to Peru some time after the arrival of the Spaniards, and it was cultivated there, for about a century and a half, with so extraordinary success, that an instance is recorded of two hundred and seventy-two fold increase; and though this valuable grain was afterwards rendered generally abortive throughout the country, and ceased to be anywhere cultivable by the aid of guano, yet all the arable lands on which it refused to grow, continued, by means of this manure, to be richly and constantly productive in millet and maize. Neither fallowing nor rotation of crops was allowed to the lands; and yet, with the help of guano, a perpetual series of remunerating crops was obtained. In the province of Arequipa at the present day, wheat manured with horse dung never yields more than eighteen for one, while maize manured with guano yields thirty-five for one, and potatoes manured with guano yield forty-five for one; and in the valley of Arica, in former times, the use of guano not only caused as great an increase as this in all the kinds of grain known in the country, but occasioned a four-hundred-fold or five-hundred-fold increase of the choicest kind of leguminous plants. A writer of about 130 years ago,—speaking of the *Capsicum baccatum*, called by the natives axi, which is used by the Peruvians as a condiment to all kinds of food, and is raised within the jurisdiction of Arica alone to the annual value of 600,000 dollars,—says, "The produce of axi is considerable, far beyond what could be expected from the size of the plant; and this prodigious result is obtained with guano or the ordure of birds brought from Iquique, which fertilizes the land in such a manner that it yields 400 and 500 for 1 in all sorts of grain, wheat and maize, and more particularly axi, when people know how to manage it in a proper manner. The seeds having come up, and the plants being in a fit state for setting, they are laid down on slanting ground, in order that the trenches, which bring on the water designed for irrigation, may convey it gently to each stem. As much guano is then put to each plant as will rest on the palm of the hand; when the flower is formed, they add a little more: and, finally, as the pod appears, a good handful is thrown in; but, as it never rains in that part of the country, great care is always taken to have the plants watered, experience having proved that, without this precaution, the salts in the manure, not being diluted, would be apt to burn them. For this reason the guano is applied at intervals, and with great care, the necessity of which has been taught by practice, and by noticing the difference observable in the crops obtained." In the Peruvian valleys, where the ancient method of using the guano continues to be followed to the present day, the axi and all sorts of fruit-trees, evergreens, and flowering-plants are remarkable for luxuriance and beauty, the vine yields a superior quality of grapes for the wine-press, the sugar-cane attains maturity in 18 or 24 months, and the alfalfa, a species of lucerne, grows in prodigious abundance, rises up to a great height, and yields six crops a-year during an indefinite number of years.

The aboriginal Peruvians of the time of the Spanish conquest, and also the subsequent mixed inhabitants of their country down to quite a recent period, seem to have confined their use of guano to the mere surface or fresh coating of the most accessible deposits. The aborigines possessed no better sea-craft than balsas and canoes, and could not venture out to the more distant islands, and were physically limited by the mere headlands and insulated rocks of the coast; and they seem to have made their gatherings of guano at only one season of each year, and never used the pick-axe or the spade for it, and probably collected only the quite recent droppings; and both they and their successors left many entire deposits untouched, and treated the lower parts of even the best or most accessible deposits as unworthy of their attention.

In modern times, first the very rapid decline of the aboriginal population, next the destruction of the Peruvian export trade of grain to Guayaquil and Panama, and next the extensive abandonment of the pursuits of agriculture for those of mining, have occasioned an enormous decrease in the local use of guano. Winterfeldt estimates the annual consumption of guano at from 600 to 700 tons around Arequipa, and at something more in the province of Tarucapa and in the valleys of Tambo and Victor; other parties estimated the annual consumption of white and red guano in all Peru, in 1828, at 600 or 700 tons; and Mr. Walton, who has enjoyed particular opportunities of being well-informed on the subject, strikes a very low key, and says, "From all the inquiries which I have been able to institute upon the spot, I am inclined to believe that, at the commencement of the present century, when the fairest criterion may be formed, the total consumption of guano by the modern mixed inhabitants of Peru, did not go much beyond 125 tons."

The delay of Britons to import Peruvian guano as a fertilizer till quite a recent period, proceeded from no ignorance of the existence and value of the manure, and simply evinced the stubborn reluctance which very generally characterizes them to adopt any new expedient. Our historians and geographers long ago adverted to the existence, the use, and the manurial powers of guano in Peru, as ordinary facts. Robertson, for example, says, "The ancient Peruvians enriched the soil by manuring it with the dung of sea-fowls, of which they found an inexhaustible store in all the islands situated along their coasts; and the Spaniards have adopted that custom from the ancient Peruvians, and continue to use the guano, or the dung of the sea-fowls, as manure." Our navigators, during upwards of a century past, saw the guano islands, and observed the deportation of the guano from them to the adjacent mainland; and whenever they went on shore, they must have witnessed the extraordinary luxuriance of crops and herbage which the manure produced. Our merchants who, ever since the declaration of independence, have had opportunities of forming establishments either on the coast or in the interior of Peru, must often have observed both the use of guano and its powerfully fertilizing effects; and even some of our countrymen who were engaged in various enterprises on the western coast of South America so early as 1815, can scarcely fail to have noticed and admired the peculiar agriculture of the natives, and to have communicated their thoughts upon it to their friends at home. Humboldt, on his return from South America, sent a sample of guano to two of the most distinguished chemists in France, accompanied by a short account of its use and practical powers as a manure in Peru; Mr. Walton, so early as the year 1810, mentioned the subject of guano to the late Lord Sheffield, the late Sir Joseph Banks, and other influential persons in London; Sir Joseph Banks, in his turn, made efforts to communicate knowledge respecting guano, and to excite an interest in it among agriculturists; and, in 1816, General Beatson, an experienced and scientific agriculturist, published a pamphlet, not only recommending guano as distinguished men before him had done, but reporting some successful trials which he had made of it in St. Helena, and showing, from his own experiments and observations, its superiority as a manure to both hogs' litter and horse-dung. But though the subject was now far more than enough known to have secured the instant and deep attention of all the leading agriculturists of the kingdom, and though several parcels were afterwards, from time to time, brought over by interested parties for trial, guano was not commercially introduced to Britain till 1840, and even then in no greater quantity than 20 casks, and was not formally introduced to the notice of the public by any high authority till 1841, when Lord Stanley mentioned it at the dinner of the Liverpool meeting of the Royal Agricultural Society of England.

The market-value of guano in Peru, at the beginning of the present century, when the native use of the manure had exceedingly diminished, and when no demand for it as yet existed in other countries, was little more than nominal; but as soon as foreign merchants displayed an interest in it, and began to ship it in their vessels as a return cargo to Europe, the Peruvian government, as lord of the soil, asserted their right of property in all the existing deposits of it, and erected the sale of it into a monopoly. The first considerable contract made with them for a supply was on the part of several united British houses, and stipulated for a four years' exclusive privilege to export it from the Isla de Norte, the little islands of Chincha, or other places, to the amount, if required, of 20,000 tons in each of the four years, and at the rate of 30 dollars per ton.

In 1841, seven British vessels brought into the ports of Britain 1,733 tons of guano; in 1842, 41 British vessels brought 12,003 tons, and 3 foreign vessels brought 1,091 tons; in 1843, 13 British vessels brought 4,056 tons; in 1844, 286 British vessels brought 81,902 tons, and 1 foreign vessel brought 207 tons; and in 1845, 679 British vessels brought 219,764 tons, and 4 foreign vessels brought 1,170 tons. In October 1841, agents in Liverpool and London, in long explanatory letters, recommended the general use of guano as a fertilizer; and in the following years, commercial enterprise was singularly active in importing supplies from both Peru and Ichaboe, and agricultural enthusiasm, in at least the most improved districts of our country, was almost as singularly excited to give the new manure a fair and very ample trial.

About 29,000 tons of the total quantity brought to Britain up to the close of 1844, were estimated to have been imported from Peru; and, previous to the same period, some shipments of it were also made from Peru to France. But a portion of that brought to Britain—though comparatively a very small portion, and intended no doubt for the mere purpose of experiment—was re-shipped to Jamaica; and thus a manure was sent to the West Indies at an ultimate cost of £12 per ton, and after a circuitous voyage of 5 or 6 months round Cape Horn to Britain and backward, which with proper management might have been obtained in two or three weeks at a cost of £3 across the isthmus of Panama and direct thence to Jamaica; yet though it cost much, it promises to be a boon to the planters, and has proved itself well-adapted to their cultivation of the sugar-cane.

The estimated amount of the Ichaboe proportion of the general import up to the close of 1844, as well as a vidimus of the general state of the guano trade at that date, are stated in the following succinct terms by Mr. Walton: "According to letters received from Ichaboe, and dated towards the close of August, it appears that, up to that period, 120 vessels had arrived there in search of cargoes, and several more were also expected. Allowing 400 tons to be the average stowage of each, it is therefore believed that, in the course of the current year, 1844, we shall have received from 65,000 to 70,000 tons of guano from that quarter alone. The Ichaboe vessels are now fast arriving in different parts of the United Kingdom, more especially at Liverpool, where the abundance of African guano has become so great, that some cargoes on board were sold at auction, and others bought in, owing to a remunerating price not being offered. As an encouragement to this new branch of trade, by a recent order from the Lords Commissioners of Her Majesty's Treasury, guano, imported in British bottoms from Ichaboe or other places on the African coast, when sold at auction, for the first time has been exempted from the payment of half per cent. duty heretofore charged. The arrivals at Liverpool have, in fact, of late so far outstripped the demand, that it was deemed necessary to bond several cargoes, in consequence of which the stench emitted from so large a quantity, stored in the Queen's Warehouses, became so intolerable, that at one moment the porters employed in them actually refused to continue working." He then states that shipments had commenced to Hamburg, that considerable orders had been received for the vineyards of France, and that a demand for exportation of African guano to the European Continent was confidently expected to increase.

The guano imported in 1841 sold at from 22s. to 28s. per cwt.; that imported in 1842 sold at from 14s. to 15s. per cwt.; and that imported in 1843 sold at from 9s. to 10s. per cwt. Toward the middle of November, 1844, Peruvian guano sold in Britain at £10 per ton, and Ichaboe guano sold at from £5 12s. 6d. to £6 per ton. In 1841, Professor Johnston, in a communication in the Journal of the Royal Agricultural Society, detailed an elaborate inquiry, by appeal to experiment and to other tests, into the true value of guano, compared with that of other manures, and with the ascertained or problematical results upon crops grown with it; and he states the conclusion as follows: "From these theoretical considerations we should say that the practical farmer ought not to purchase guano at a higher price than 20s. per cwt.,—a price which, in the opinion of Mr. Pusey, the farmer may probably afford to pay,—which, according to Mr. Winterfeldt, would more than remunerate the importer,—and below which, according to the chemist, an artificial guano of equal efficacy may be prepared in England, and from the superabundant produce of our own manufactories." A suggestion was made in 1846 that our government should be asked to negociate with that of Peru for the reduction of the export duty on guano, and that an agricultural club should be formed for undertaking and managing the whole trade in the importation of Peruvian guano; and the results of following out this suggestion, it is alleged, would be the reduction of the cost of guano at least 25 per cent. below the present prices, the proper regulating of its annual supply, and the preventing of adulteration whether at the taking up of the guano in Peru or after the landing of it in Britain.

Analyses of Guano.—The guano of commerce is exceedingly diversified both in appearance and in chemical composition. Some is wholly or partially an artificial compound; and may be almost endlessly diversified, both in its artificial constituents, and in the kind and proportion of its genuine intermixture. Most is very perceptibly intermixed with alluvial matters; and much contains a large but very variable amount of earthy ingredients, taken up from the ground on which the deposit lay. The pure guano of cold and wet countries has a general appearance corresponding to the character of insoluble salts; and the pure guano of hot and dry countries has a general appearance corresponding to the character of soluble and evaporable substances. The guano of different spots in any one district presents many diversified appearances according to its comparative purity, to its comparative age, to the particular birds which have deposited it, and to the particular circumstances of weather and exposure which have modified it.—The greater part of the Peruvian guano brought to Britain has a peculiar putrid odour, and seems a slightly damp and deep reddish-brown powder, with intermixtures of hard lumps; and some of these lumps are stones, while most consist of the least decomposed portions of the pure guano, and exhibit, when broken, a whitish surface on their fracture, and numerous interspersions of small crystals. Another common variety of imported Peruvian guano, is damper than the preceding, smells very distinctly of ammonia, has a dark greyish colour, and contains more stones and fewer hard lumps of partially decomposed guano than the deep reddish-brown kind.

The African guano, while possessing many diversities within itself, is aggregately less dense than any of the imported varieties of Peruvian guano, and is nearly free from hard lumps; and in many instances, especially when it is pretty dry, it abounds in small silky crystals of oxalate of ammonia.

The chemical constitution of any one natural variety of guano differs according to its age and comparative purity, and the analyses of the several varieties of genuine guano, not only from different regions but from the same district, differ more or less from one another; and yet the chemical constitution of each variety may be said to have a kind of normal character, while that of all the genuine varieties can both be exhibited in a comparative table, and reduced to an average estimate. The great power of guano as a manure renders every possible knowledge of its chemical composition important; and the great diversities of that power in the different varieties, as well as the diversities of adaptation and the differences of market-value, render a large number of special analyses desirable.

A sample of Peruvian guano, brought to Europe by Humboldt, was found, according to an analysis by Klaproth, to consist of 16 per cent. of urate of ammonia, 10 of phosphate of lime, 12·75 of oxalate of lime, 4 of silica, 0·5 of common salt, 28 of sand, and 28·75 of water and organic and combustible matter. But this sample was evidently ill selected, and contained so very much silica and silicious and argillaceous sand as to be a totally unfair specimen of any of the tolerable good varieties of Peruvian guano; and Dr. Ure, who has amply entitled himself to be regarded as an authority on the subject, states that he had never met a specimen which contained any appreciable quantity of clay, or more than 4 or 5 per cent. of silicious sand. Another sample, brought to Europe by Humboldt, was found, according to an analysis by Fourcroy and Vauquelin, to consist of 9 per cent. of urate of ammonia, 10·6 of oxalate of ammonia, 7 of oxalate of lime, 6 of phosphate of ammonia. 5·5 of sulphate of potash, 3·3 of sulphate of soda, 4·2 of sal ammoniac, 14·3 of phosphate of lime, 4·7 of clay and sand, and 32·3 of water and organic matters.

Two analyses are quoted by Liebig, and seem to be extensively regarded as of much authority,—the one of a specimen from Liverpool by Bartels, and the other of a specimen from Lima by Völckel. Bartel's specimen consisted of 6·5 per cent. of muriate of ammonia, 13·351 of oxalate of ammonia, 3·244 of urate of ammonia, 6·25 of phosphate of ammonia, 0·6 of a waxy substance, 4·227 of sulphate of potash, 1·119 of sulphate of soda, 5·291 of phosphate of soda, 4·196 of phosphate of magnesia and ammonia, 0·1 of common salt, 9·94 of phosphate of lime, 16·36 of oxalate of lime, 0·104 of alumina, 5·8 of residue insoluble in nitric acid, and 22·718 of water and organic matters. Völckel's specimen consisted of 4·2 per cent. of muriate of ammonia, 10·6 of oxalate of ammonia, 9 of urate of ammonia, 6 of phosphate of ammonia, 5·5 of sulphate of potash, 3·8 of sulphate of soda, 2·6 of sulphate of magnesia and ammonia, 14·3 of phosphate of lime, 7 of oxalate of lime, 4·7 of residue insoluble in nitric acid, and 32·3 of water and organic matters.

An analysis of guano by T. Oellacher, apothecary at Innsbruck, has been thought worthy of considerable attention. The specimen employed in it was of a brownish-yellow colour and of a knobby consistency, the powdery portions of it being mixed with light laminated crystalline portions in white grains, from the size of a pea to that of a pigeon's egg; and it was found to consist of 12·2 per cent. of urate of ammonia, 17·73 of oxalate of ammonia, 1·3 of oxalate of lime, 6 of phosphate of ammonia, 11·63 of phosphate of ammonia and magnesia, 20·16 of phosphate of lime, 2·25 of muriate of ammonia, 0·4 of common salt, 0·8 of carbonate of ammonia, 1·65 of carbonate of lime, 4 of sulphate of potash, 4·92 of sulphate of soda, 1·06 of humate of ammonia, 0·75 of a waxy substance, 1·68 of sand, 4·31 of hygroscopic water, and 8·26 of organic matter. Dr. Ure, however, states that Oellacher's sample was widely different from all the fresh samples which had passed through his own hands, and expresses a conviction that, from the large proportion of oxalate of ammonia which it contained, it was by no means a fair or normal specimen of guano. Dr. Ure also says respecting, not only Oellacher's analysis, but also the analyses of Bartels and Völckel,—and the remark applies to many other analyses which have been published for the guidance of the purchasers of guano,—"All are defective in not showing the total quantity of ammonia which the guano is capable of giving out in the soil; and since it appears that the freshest guano abounds most in potential ammonia, it must possess, of consequence, the greatest fertilizing virtue."

Analyses of two kinds of guano, widely different from the ordinary ones of commerce, the one from Peru and the other from Africa, are given by Dr. Shier in his edition of Sir Humphrey Davy's Agricultural Chemistry. His sample of the Peruvian kind was dry, cream-coloured, singularly fresh, remarkable for having most of its nitrogen in uric acid, and seeming, from its aggregate appearance and character, very similar to the white variety of Peruvian guano, so highly appreciated in Peru, and very rarely, almost never, included in the importations to Britain; and this sample consisted of 6·8 per cent. of water, 2·71 of ammonia, 34·7 of uric acid, 2·94 of sulphate of soda, 0·86 of common salt, 0·48 of alkaline phosphates, 1·36 of carbonate of lime, 19·24 of phosphates of lime and magnesia, and 4·52 of silicious grit and sand. His sample of the African kind was from Possession Island, and was darker, damper, and denser than the ordinary Ichaboe guano, and readily parted with a portion of its water in a dry atmosphere, and assumed a light grey colour with a glistening appearance under the lens, and seemed, from its containing numerous fronds of sea-weed, to have been collected close to the beach, and also contained some bones of birds and tufts of seal's hair; and this sample consisted of 30·8 per cent. of water, 5·95 of ammonia, 3·6 of ulmic and humic acids, 1·84 of sulphate of soda, 2·45 of common salt, 2·61 of alkaline phosphates, a trace of carbonate of lime, 17·96 of phosphates of lime and magnesia, and 11·54 of silicious grit and sand. Dr. Shier tabularly exhibits these two analyses along with analyses of a light brown sample considerably damper than his first, but from the same cargo,—of a fine sample of the lighter brown Peruvian sorts,—of a drier and darker Peruvian sample,—and of a sample of the ordinary Ichaboe guano of commerce; and he observes in reference to the whole, "It would appear from them that the African guanos are more decomposed than most of those from South America. If this prove to be always or generally the case, it will become a matter of the greatest importance to ascertain whether the fresh guanos are decidedly more permanent in their effect than the decomposed ones; for, if so, the two kinds to be used most economically, would require to be applied at very different periods of the ordinary rotations, and perhaps to different crops."

The average result of a number of analyses of guano, performed with the greatest care and with the aid of the most complete apparatus, by Dr. Ure, for the London and Liverpool co-agents of the Peruvian and Bolivian governments, exhibits 1 per cent. of silicious sand, 11 of water, 25 of phosphate of lime, 13 of ammonia, phosphate of ammonia, oxalate of ammonia, and phosphate of magnesia, and 50 of azotized animal matter, including urate of ammonia, and assumes the second-last of these items to contain altogether from 5 to 9 of ammonia, and the last to be capable of affording from 8 to 16 per cent. of ammonia by slow decomposition in the soil. A sample of dry, pale-yellow Bolivian guano, considered by Dr. Ure to be a type of the substance in its best state, was found, after being freed from a few obvious intermixtures of small granite fragments, to consist of 6·5 per cent. of water, 5 of urea, 7·9 of sulphate of potash, 5 of common salt, 5·5 of biphosphate of ammonia, 0·6 of oxalate of ammonia, 2·25 of silica, 9 of subphosphate of lime, 1·25 of phosphate of magnesia and ammonia, 15·27 of urate of ammonia, and 41·73 of undefined ozatised organic matter, affording with the other nitrogenous principles, 17·05 parts of ammonia. A sample from the Chincha Islands, of nearly the same colour and dryness as the preceding, was found to consist of 8·5 per cent. of water, 6 of sulphate of potash, with a little sulphate of soda, 3 of muriate of ammonia, 14·32 of phosphate of ammonia, 1 of sesquicarbonate of ammonia, 2 of sulphate of ammonia, 3·23 of oxalate of ammonia, 8·95 of urea and soluble organic matter, 1·25 of silica, 9·52 of undefined organic matter, 14·73 of urate of ammonia, 1 of oxalate of lime, 22 of subphosphate of lime, and 4·5 of phosphate of magnesia and ammonia; and it contained, within the ammoniacal principles, a total per centage of 9·8 of ammonia. A prime sample of African guano consisted of 21·5 per cent. of water, 23 of subphosphate of lime, 3 of magnesian phosphate of ammonia, 1 of silica, 1·5 of alkaline sulphate and muriate, and 50 of decayed organic matter, with phosphate of ammonia and a little carbonate; and other samples of African guano afforded from 24 to 36 per cent. of moisture, from 5 to 7 of phosphate of ammonia with a little carbonate, from 25 to 35 per cent. of subphosphate of lime, 5 or 6 of the magnesian phosphate of ammonia, more or less oxalates from the decomposition of uric acid, and from 3 to 5 per cent of fixed alkaline salts.

These details of analyses are tedious, and may at first sight seem unnecessarily multiplied; yet all we have given, and perhaps a number more, are necessary in order to afford hints for the selection of guano, and to evince the great variety of its character, the broad differences of its value, and the wide range of its adaptations. Some of the conflicting analyses may be understood, too, as pointing, not only to importations from different regions, or to cargoes from different deposits or in different seasons, but sometimes to the guano of a single shipment or even of a single box. For example, one of two small portions taken at random, by Professor Johnston, from a box of about 20 pounds' weight, was found by analyses to consist of 1·8 per cent. of sulphate of soda, 30·3 of common salt with a little phosphate of soda, 44·4 of phosphate of lime with a little phosphate of magnesia and carbonate of lime, and 23·5 of water, salts of ammonia, and organic matter expelled by a red heat; and the other portion was found to consist of 11·4 per cent. of common salt with a little sulphate and phosphate of soda, 29·3 of phosphate of lime with a little phosphate of magnesia and carbonate of lime, 7 of ammonia, 0·8 of uric acid, and 51·5 of water, carbonic acid, oxalic acid, and other principles of organism expelled by a red heat. Cargoes of guano, also—as may be abundantly inferred from some of our statements respecting both the physical and the economical history of the manure—are sometimes enormously deteriorated by mixtures of alluvium and detritus, and may be regarded, in the aggregate, as exceedingly different from one another in the proportion of worthless earthy matter which they contain; yet pieces of gravel, and all other obviously alluvial and detrital fragments which admit of easy mechanical separation, are totally left out of the account of most of the analyses which we have quoted, as well as of others which have been published for the guidance of purchasers. The two samples just alluded to, as taken from one box and analysed by Professor Johnston, contained respectively 8 per cent. and 1·2 per cent. of sand; other specimens of good imported guano, examined by the same analyst, contained from 2 to nearly 11 per cent. of sand; and one of the specimens brought home by Humboldt, as we formerly saw, contained 32 per cent. of silica and sand.

"Dr. Von Martius," says Dr. Ure, "proposes to use the degree of solubility of the guano in water as a good criterion of its quality; but this is a most fallacious test. Sound guano contains from 20 to 25 per cent. of insoluble urate of ammonia; nearly as much undefined animal matter, along with from 15 to 20 of earthy phosphates, leaving no more than 50 or 55 per cent. of soluble matter, exclusive of moisture; whereas decayed guano yields often 60 to 70 per cent. of its weight to water, in consequence of the uric acid and animal matter being wasted away, and the large portion of moisture in it, the latter amounting very often to from 25 to 35 per cent. The good Peruvian guano does not lose more than from 7 to 9 per cent. by drying, even at a heat of 212° F.; and this loss necessarily includes a little ammonia. Each analysis of guano executed for the information of the farmer should exhibit definitely and accurately to at least 1 per cent.:—1. The proportion of actual ammonia. 2. The proportion of ammonia producible also from the uric acid and azotized animal matter present, and which may be called the potential ammonia. This is a most valuable product, which is, however, to be obtained only from well-preserved dry guano. 3. The proportion of uric acid, to which if 1-11th of the weight be added, the quantity of urate of ammonia is given. 4. The proportion of the phosphates of lime and magnesia. 5. The proportion of fixed alkaline salts, distinguishing the potash from the soda salts; the former being more valuable, and less readily obtainable; the latter can be obtained by the use of common salt. Wheat, pease, rye, and potatoes require for their successful cultivation a soil containing alkaline salts, especially those of potash. 6. The proportion of sandy or other earthy matter, which in genuine guano, carefully collected, never exceeds 2 per cent., and that is silica. 7. The proportion of water, separable by the heat of 212° F.

"The farmer should never purchase guano, except its composition in the preceding particulars be warranted by the analysis of a competent chemist. He should cork up in a bottle a half-pound sample of each kind of guano that he buys; and, if his crop should disappoint reasonable expectation, he should cause the samples to be analyzed; and should the result not correspond to the analysis exhibited at the sale, he is fairly entitled to damages for the loss of his labour, rent, crop, &c. The necessity of following this advice will appear on considering the delusive, if not utterly false, analysis under which cargoes of guano have been too often sold. In a recent case, which came under my cognizance in consequence of having been employed professionally to analyze the identical cargo, I found the guano to be nearly rotten and effete, containing altogether only 2½ per cent. of ammonia, ½ per cent. of urate of ammonia, nearly 9 of sea-salt, 24 of water, and 45½ of earthy phosphates. Now, this large cargo, of many hundred tons, fetched a high price at a public sale, under the exhibition of the following analysis:—17·4 per cent. of urate of ammonia, ammoniacal salts, and decayed animal matter, 48·1 of phosphate of lime, phosphate of magnesia, and oxalate of lime, 10·8 of fixed alkaline salts, 1·4 of earthy and stony matter, and 22·3 of moisture. The purchasers, I was told by the broker, bought it readily, under a conviction that the guano contained 17·4 of ammonia, though the proportion of ammonia is not stated.

"By the following hypothetical analysis much guano has been well sold:—Bone earth, 35; lithic acid, &c., 15; carbonate of ammonia, 14; organic matter, 36 = 100. I am quite certain that no sample of guano can contain 14 per cent. of carbonate of ammonia—a very volatile salt. It may contain at the utmost 5 per cent. of the carbonate; but such guano must have been acted upon powerfully by humidity, and will therefore contain little or no uric acid. In the very elaborate examination of guano by T. Oellacher, it is said, that if a glass rod dipped into muriatic acid be held over guano, strong fumes are developed; and the solution of guano has an alkaline reaction with litmus paper. These phenomena evidently indicate the presence of carbonate of ammonia, and of course a partially decomposed guano: for sound Chincha and Bolivian guano have an acid reaction, proceeding from the predominance of phosphoric acid. Farmers frequently judge of the goodness of guano by the strength of the ammoniacal odour; but in this judgment they may egregiously err, for the soundest guano has no smell of ammonia whatever; and it begins to give out that smell only when it is more or less decomposed and wasted."

The surest criterion of the soundness of guano, according to the same writer, is the proportion of ammonia which can be extracted by the action of hydrate of soda and quicklime. We obtain, by this process, not only the ready-formed ammonia from its several saline compounds, but also the ammonia producible from the uric acid and from the undefined animal matter. These two latter substances, though often comparatively little attended to by analysts, constitute the most durable fund of nitrogen for the nutrition of plants. Both uric acid and urate of ammonia—the latter of which contains ten-elevenths of the former—are nearly insoluble in water, and continue fixed at ordinary temperatures; and they comprise one-third of their whole weight of nitrogen, and give it out continuously and progressively to the soil. Uric acid, under the influence of oxygen and a certain temperature, undergoes a remarkable series of transformative decomposition, and produces allantoin, urea, and oxalic acid, while the last of these products itself forms new combinations, and eventually passes into carbonic acid. "From these metamorphoses," remarks Dr. Ure, "we can readily understand how so much oxalate of ammonia and lime is reported in many analyses of guano; though none, I believe, is to be found in the normal state, as it is occasionally imported from the Chincha Islands and Bolivia; nor were any oxalates found in the dung of the gannet as analysed by Dr. Wollaston, or of the sea-eagle according to the analysis of Coindet."

Gross adulterations or spurious imitations of guano can, with little difficulty, be so skilfully manufactured as to possess the colour, the smell, the consistency, and the general appearance of genuine guano. Any farmers, therefore, who have not opportunity or inclination to use precautions founded on analyses of guanos, ought to purchase only at prices which seem to be a fair equivalent for the particular kind of genuine guano which they select, and only from parties who have evinced thorough honesty in dealing, and who always display a willingness to submit their specimens to chemical analysis. So simple a circumstance as the occurrence of birds' feathers in guano ought not to deceive any one; for the feathers, of course, can easily be artificially intermixed. The undue heaviness of a specimen, and the character of the residue from combustion, are sometimes facile and decisive criteria. One spurious composition offered for sale as Peruvian guano was found, by analysis, to consist of 31·5 per cent. of common salt, 28 of common silicious sand, 5·2 of copperas, 4 of phosphate of lime, 23·3 of organic matter from bad guano, and 8 of water; but this trash did not require analysis for its detection, for it had a specific gravity of 2·17, while good fresh guano has a specific gravity of only 1·66, and, when burned upon a red-hot shovel, it left a black fused mass of salt, sand, and copperas, while genuine guano leaves a white ash of phosphate of lime and magnesia, so that it might have been readily detected by either gauging or burning it. But artificial preparations in imitation of guano, whether passed off for actual guano, or somewhat honestly though very inappropriately called artificial guano, are exceedingly various in both appearance and composition; and, though, in the present rapid progress of chemico-agricultural science, artificial mixtures of more real value or higher fertilizing power than genuine fresh guano may possibly be soon discovered, yet most of the artificial guanos hitherto produced are pushed off at prices far above their real value, and cannot be relied on for proper fertilizing action on the soil.

The native British guanos mentioned in our notice of the physical history of the manure, possess, as was there stated, a very different constitution from the Peruvian and African guanos, and contain a comparatively large intermixture of silicious sand. The Scarborough guano has a light brown colour, seems a mixture of a fine powder with bits of straw and chaff and with a little sand and gravel, and emits a peculiar smell, but does not give off an ammoniacal odour till moistened and mixed with lime; and, according to a coarse yet sufficient analysis, it consists of 6 per cent. of hygrometric water, 24 of organic matter, chiefly vegetable, insoluble in water, and destructible by fire, 10 of saline matter, soluble in water, and containing lime, potash, ammonia, magnesia, muriatic acid, sulphuric acid, and nitric acid, 21 of matter indestructible by fire but soluble in muriatic acid, and consisting chiefly of phosphate of lime, with a little carbonate of lime and magnesia, and 39 of matter indestructible by fire, insoluble in muriatic acid, and consisting principally of silicious sand and gravel. The guano of the Little Pentland Skerries exists in firm lumps, has a dirty brown colour, occasionally speckled with white, emits a peculiar smell, not unlike that of sea-weed, and unmixed with any ammoniacal odour, gives off a pretty strong smell of ammonia when triturated with lime, and appears, when carefully examined through the microscope, to be composed of a fine granular matter, particles of silicious sand, and minute fragments of sea-shells and of sea-weed; and, according to a coarse analysis, it comprises 8 per cent. of hygrometric water, 4 of matter soluble in water, and consisting principally of muriate of ammonia, and nitrate and sulphate of lime, with a trace of common salt, 28 of matter destructible by fire, nearly insoluble in water, and consisting of a mixture of vegetable and animal principles, 30·6 of matter indestructible by fire, and consisting of carbonate and phosphate of lime, with a trace of magnesia, and a little sulphate of lime, and 29·4 of matter indestructible by fire, and consisting of silicious sand. British guanos, therefore, in spite of their wide difference of character from Peruvian guanos, cannot but possess great manurial power, and are abundantly worthy of being sought out and collected.

The Fertilizing Power of Guano.—Guano owes much of its fertilizing power to its being a well-tempered mixture of a considerable or even large number of the substances and proximate principles which cultivated plants require for their growth and perfect development. It owes a good deal also to the particular transformative decomposition of some of these substances, and to the harmonious and successive resolution of all in an order suited both to the stages of growth in the first crop, and to the gradations of progress in an ordinary rotation. It owes a little likewise to the presence of common salt; which is derived partly through the same medium as the other substances, and partly from the saline vapours prevailing over the whole surface of the guano-deposits; and which, though variable in quantity, is always sufficiently present both to take a part in the general transformations of the manure, and to aid the other ingredients in producing their full effect upon the living vegetable. Yet these three sources of the fertilizing power must be regarded as only secondary or adjective; while the primary and substantive sources are ammonia for promoting the early growth of plants, and phosphates, particularly the phosphate of lime, for promoting their healthy and luxuriant maturity; and in all thoroughly good guano, the former of these sources contains a reserve for the after-crops of a rotation, as well as an immediate supply for the first crop, while the latter slowly, steadily, and equably expends itself throughout a limited course of years.

The ready-formed ammonia, existing in the saline forms of carbonate, sulphate, muriate, phosphate, and oxalate, is a highly important principle in all animal manures, whether natural compounds or artificial composts, and probably acts a most energetic part on all cultivated vegetables in every climate; and the comparatively high proportion of it which occurs in guano, explains the great power of that manure in giving extraordinary health and vigour to young vegetation. See the article AMMONIA. But the ammonia which is slowly and steadily produced by the combination of free hydrogen with the nitrogen evolved from the undefined animal principles of guano, and especially from its uric acid, is of still higher importance, both for sake of the great power with which it acts, and on account of the large proportion which it bears to the weight and volume of its source. Pure uric acid, under the most favourable circumstances, though seldom if ever under such as occur in nature, might yield 40 per cent. of pure ammonia; and —as has already been made apparent by our statements respecting the analyses of different kinds—Peruvian guano is rich in uric acid in the degree of its freshness, and when nearly quite fresh is singularly rich in it. The newly-dropped excretions of the gannet, after being dried, were found by Dr. Wollaston to consist almost wholly of uric acid; and the solid excretions of the sea-eagle were found by Coindet to consist of 84·65 per cent. of uric acid, 9·22 of ammonia, and 6·13 of phosphate of lime. We can easily understand, therefore, why the ancient Peruvians found quite recent guano so much more powerful than oldish guano,—why they skimmed off the new deposits year by year, and left the ancient accumulations comparatively undisturbed,—why they so rigidly protected the sea-fowl from destruction or disturbance,—and why the recent guano continues at the present day to bring, on the coast of Peru, so much higher a price than oldish guano.

While the ammoniacal principles of guano affiliate it to the strongest and best kinds of ordinary animal manures, its phosphates, particularly its phosphate of lime, affiliate it to bone-manure; so that, in a general view, it performs the aggregate of fertilizing action which might be expected from a compost of bone-dust and the animal portions of prime farm-yard manure. Though agricultural plants well-fed with ammonia spring up of a bright green colour, and shoot upward with vigour; yet, unless they have also a due supply of phosphates, they never attain a healthy maturity, or produce an adequate return of nourishing food. See the article PHOSPHATES. Bone-manure owes much of the power and nearly all the permanence of its fertilizing action, and in consequence most of its suitableness for the rotational husbandry, to its great wealth in phosphate of lime; for while its organic principles, for the most part, decompose and disappear in one season, or at the utmost in two seasons, its phosphate of lime or bone-earth remains long in the land, and is very slowly and quite steadily withdrawn from the soil by the crops and other natural agencies. Now guano is, weight for weight, 50 per cent. richer in phosphate of lime, than even crushed bones; and, in the same proportion, must it act with permanently fertilizing power upon the soil. "This fact," remarks Professor Johnston, "is of great practical importance. Nitrate of soda, so much used of late, and so deserving of more extensive trial, may be washed out of the soil, where the earthy part of the guano would remain; it may cease to exert a marked influence after a single crop, where it is scarcely possible that the phosphates of the guano should cease to act; and it may fail to bring to maturity crops of corn or to fill the ripened ear, when the guano would supply to the grain, among other substances, the earthy phosphates also, which the seed contains as a necessary constituent." An excess of the nitrogenous power of a manure over the phosphatic, whether the former be derived from ammoniacal salts, from azotised animal principles, or from the nitrates of soda and potash, has the serious disadvantage, too, of so flushing up a crop as to make it look luxuriant and promising, while its weight of corn may be disproportionately small and exceedingly disappointing; and hence the vast practical value of a concurrence of great ammoniacal wealth with equally great phosphatic wealth in the constitution of all good guano.

Some examples of the extraordinarily fertilizing power of guano in Peru were given in our account of the economical history of the manure, and more might be given here; but none of them ought to be taken as an index of what guano can effect in Britain. Where the soil is arid sand, and rain seldom falls, and dews are comparatively rare, and the prevailing temperature is high, guano, with the help of irrigation, makes the plant rush rapidly and luxuriantly up to maturity before the burning sun and the parching winds have time to scorch and wither it; but in the strong soils and cold climate of Britain, and under the abundant moisture which almost constantly prevails, it performs a widely different course of action, and must always produce effects of a far tamer and less rapid character. But the malign influence which, on the other hand, has been occasionally ascribed to it, is incomparably more fanciful than extravagant notions of its fertilizing power. The droppings of geese, when they lie undiluted upon growing grass, speedily damage or destroy it, but, when diluted and dispersed, render it vigorous and luxuriant; and guano, on the same principle, has in any case injured agricultural and garden plants instead of benefiting them, only when it has been put into actual contact with their epidermis, or intermixed in too large proportion with the soil.—*Edinburgh New Philosophical Journal.* —*Darwin's Researches in Geology and Natural*

History.—Papers of Mr. Walton and other writers in the Quarterly Journal of Agriculture.—Papers of Dr. Ure, Professor Johnston and other writers in the Journal of the Royal Agricultural Society of England.—Davy's Agricultural Chemistry by Shier.—The Farmer's Magazine.—Liebig's Chemistry of Agriculture.—Johnston's Lectures on Agricultural Chemistry.

GUATIMALA. See INDIGO.

GUATTERIA. A genus of ornamental, tropical, ligneous plants, of the custard-apple tribe. Five species, varying in natural height from 3 to 35 feet, and all possessing a beautiful evergreen colour somewhat similar to that of the magnolias, have been introduced to Britain; and nearly 20 other species are known. The tallest of the introduced species ranks as a timber-tree in the West Indies, and is popularly called lance-wood.

GUAVA,—botanically *Psidium*. A genus of tropical, evergreen, fruit-trees and fruit-shrubs of the myrtle family. Nearly 20 species have been introduced to Britain; and several more are known. All the introduced species are white-flowered, and very nearly all produce a delicious and much-relished fruit; and they vary in natural height from 3 to 25 feet.—The common red guava was introduced from the West Indies in the 17th century. Its stem is thick, has a smooth bark, and naturally attains a height of about 20 feet; its branches diverge from the upper part of the stem, and are numerous and angular; its leaves are opposite, oval, 2½ inches long, and 1½ inch broad at the middle, and have short footstalks, a strong midrib, and many light-green veins; its flowers are produced on footstalks from the wings of the leaves, and have five large, roundish, concave, white petals, and bloom in June and July; and its fruit is large, oval, one-celled, shaped like a pomegranate, and filled with small seeds, and has an agreeable odour. The fruit is much eaten in the West Indies, but possesses very considerable astringency, and is not suited to costive habits of body. The seeds pass through the alimentary canal undigested; and, the fruit being much eaten in the West Indies by brutes, they naturally propagate the plant and occasion crops of trees to spring up wherever they are permitted to grow.—Cattley's species, *Psidium Cattleianum*, is one of the best of the guavas, and furnishes an article of commerce which is known in the higher circles of society as a great luxury, and is imported under the name of guava jelly. This species was introduced to Britain from South America about 18 years ago, and naturally attains a height of about 25 feet, and blooms in May and June; and it is considerably hardier than any of the other introduced species, and may be grown in any good greenhouse; and when it is removed for a short time in the early part of summer to a peach-house, a vinery, or a stove, it produces an abundant crop of fruit. Its leaves are obovate, glossy, 1½ inch long, and extremely firm and durable; and they grow in such abundance on its arched and pendent branches as to render it a dense and finely-outlined mass of very rich verdure. The fruit, on young shrubs, is as large as the morello cherry; and its rind has a similar texture to that of an orange.

GUAZUMA. See BASTARD-CEDAR.

GUDGEON,—scientifically *Cyprinus Gobio*. A British fresh-water fish, of the family Cyprinidæ, and order Malacopterygii. Its body is thick and round; the lower jaw is shorter than the upper; the irides are tinged with red; the gill-covers are tinged with green and silver; the back has a dark olive colour, streaked with black; the lateral line is straight; the sides beneath that line are silvery; the belly is white; the tail is forked; and both the tail and the dorsal fin are beautifully marked with black. This fish delights most in gentle streams, with gravelly and sandy beds; but though properly a river-fish, it thrives exceedingly well in gravel-bottomed and brook-fed ponds, and may occasionally be found there of five or six pounds' weight. Its flesh is very delicious, and has about as good a flavour as that of the smelt.

GUELDER-ROSE,—botanically *Viburnum Opulus*. A deciduous, ornamental shrub, of the honeysuckle family. It grows wild in the moist grounds of England, and of most parts of Continental Europe. Its stem usually attains a height of about 10 feet, but sometimes grows to double that height; its young branches are produced sometimes in opposite pairs, but generally in an irregular manner, and have a smooth and almost white bark; its leaves stand on glandulous footstalks, and consist of three large serrated lobes or leaflets, and have a soft texture and a very verdant green colour, and change in autumn into so fine a red as to give the plant at that season a very striking and beautiful appearance; and its flowers are produced in large umbels, all over the tree, and bloom in May and June. A multitude of hermaphrodite flowers compose the body of each umbel, and make no great figure; but a border of white male flowers encompasses the hermaphrodites, and combines with the rich foliage to give the whole plant a grand look; and when the flowers have fallen, a crop of fine scarlet berries succeeds them in large bunches, and renders the shrub more imposing than almost any other bacciferous plant of our climate. Nothing but the commonness of the wild guelder-rose prevents it from being universally and highly esteemed for ornamental purposes. The spray of it is collected by poor persons, and made into skewers of about six inches long; and these are sold by the bushel to the butchers about the metropolis.

The rosy guelder-rose, or snowball-tree, *V. o. rosea*, is a very beautiful variety, of accidental origin, and long and generally diffused in gardens and shrubberies. It is strictly the same as the normal plant, in stem, branches, bark, and leaves; but it affects a taller growth, and is very broadly distinguished by the character and appearance of its flowers. These are produced in large globular bunches all over the tree, and consist of masses of white males of the same nature as those which border the floral umbels of the normal plant; and, as seen from either a small or a comparatively great distance, they seem to lie among the dense rich foliage like a multitude of balls of snow. The variegated-leaved variety, *V. o. variegata*, is also very beautiful, and usually affects about the same height as the normal plant.

GUERNSEY LILY,—botanically *Nerine Sarniensis.* A beautifully-flowering, tuberous-rooted, greenhouse plant, of the amaryllis family. It was formerly regarded as a true amaryllis, and was first assigned to a different genus by Herbert. It is supposed to have been introduced to England from Japan, a little after the middle of the 17th century; but it has, for a very long period, thriven in Guernsey and Jersey like a native plant, and been multitudinously imported thence into Britain. It rises to the height of about a foot, carries red flowers in September and October, and is one of the most common of our amaryllideous plants. Miller describes it as "the lily-daffodil, with many flowers in one cover, the petals equal, spread open, and turned backward, with broken stamina."

GUETTARDA. A genus of ornamental, tropical plants, of the madder tribe. Seven species, all evergreen trees of from 20 to 35 feet of natural height, have been introduced to the hothouses of Britain; and about ten other species are known. The showy species, *G. speciosa*, a native of India, and naturally attaining a height of about 30 feet, and producing scarlet-coloured flowers, is the largest and best known of the introduced species, and has a magnificent appearance.

GUIGNE. See Gean.

GUILANDINA. See Bordac.

GUINEA-FOWL,—scientifically *Numida Meleagris.* A domesticated bird of the gallinaceous group. It exists in a wild state only in Africa; and has thence been diffused, as a domesticated bird, through Europe and America. In its wild state, it associates in flocks of two or three hundred, and delights in marshy situations; and both in its wild and its domesticated states, it roosts on trees or on other lofty objects. It is smaller than a turkey, but larger than a large dunghill cock; it cannot be tamed out of a shy, restless, and half-wild habit; and it possesses much courage, and does not scruple to attack a turkey. It has a peculiar gait, a singular chuckle, and a harsh screaming cry; and the male and the female of it are so exceedingly like each other as not to be easily distinguished. It has such habits of feeding and domestication as sufficiently fit it to be kept in the same poultry-ground as common fowls; but it makes its nest in very secluded and secret spots, far from home, and gives no notice of laying or setting; so that its eggs cannot easily be found, and require, for the purposes of domestic propagation, to be hatched and fostered beneath a common hen. It serves as a good night-watch to a farmery or other country residence; for whenever it is disturbed during the night by the sound of footsteps, it makes such loud cries as summon the attention of the inmates. It is very prolific; both its eggs and its flesh are generally relished; and it has been supposed to combine the properties of the pheasant and the turkey. Its flesh, both in colour and in flavour, is more like that of the pheasant than that of the common cock and hen; and it possesses much delicacy, and is in fine season at Lent. Its chickens require to be kept dry and warm, and ought to receive the same food and treatment as those of the turkey; and the advanced birds, when in the course of fattening, ought, during 10 or 14 days, to be confined to the house, and fed four or five times a-day with sweet barley meal, softened with good lard, or moistened in sweet milk.

GUINEA-PEACH,—scientifically *Sarcocephalus.* A tall, evergreen, tropical, fruit-shrub, of the madder tribe. It constitutes a genus of itself, and is specifically called *esculentus* or the eatable. It was introduced to Britain about a quarter of a century ago, from Sierra Leone. It naturally attains a height of 15 or 18 feet, and carries pink-coloured flowers in July. Its popular name alludes to the character of its fruit; and its botanical name signifies "fleshy-head," and alludes to the character of its flowers.

GUINEA-PIG,—scientifically *Cavia Cobaya.* A small and beautiful Brazilian quadruped, of the order rodentia. It occurs wild in the woods of Brazil and Paraguay; and is extensively domesticated in Europe; and is treated and used in Britain in the same manner as the tame rabbit; and is often kept upon premises in the belief that its odour drives away rats. It is about seven inches long, and has a white ground colour, variegated with irregularly outlined spots of black and orange. It is enormously prolific; and, but for being unable to withstand the effects of cold and moisture, it would, in its wild state, speedily outrun all possible supplies of food in even the most luxuriant region. The female has been known to produce young ones when only two months old; her period of gestation is only three weeks; she brings forth a new brood at least every two months; and a single pair are capable, in the course of a twelvemonth, of multiplying into a thousand individuals. The young do not attain maturity of growth till they become about six or seven months old; but they are as active and alert about 12 or 14 hours after birth as when full-grown; so that they require exceedingly little parental care. The guinea-pig is eminently cleanly in its habits, and may often be seen cleansing and smoothening its fur with the most sedulous care. It is particularly fond of parsley and pomaceous fruits, but readily feeds and fattens on any one of a great number of herbaceous plants; it appears to ruminate after eating; and it drinks very little, and is exceedingly sensitive to damp and cold. Its flesh is regarded by the Italians as delicate food; and its skin is nearly as valuable as that of the rabbit.

GUINEA-PLUM, — botanically *Parinarium Excelsum.* An evergreen, white-flowered, tropical fruit-tree, of the cocoa-plum division of the rosaceous order. It was introduced to the hothouses of Britain, about 25 years ago, from Sierra Leone. It naturally attains a height of 60 or 70 feet.

GUINEA-WORM. See Filaria.

GULDENSTÆDTIA. A small genus of herbaceous plants, of the lotus division of the leguminous order. The few-flowered species, *G. pauciflora*, is a native of Siberia, and was introduced about 20 years ago to Britain. Its root is perennial; its stem is 6 or 8 inches high; and its flowers are red, and bloom in June and July. It is regarded by some botanists as a milk-vetch.

GULL. These birds are well known everywhere, being found almost universally spread over the globe. They are distinguished from other sea-fowl by their straight bill, bending downwards towards the point, and marked below the under mandible by a triangular prominence, by their light body, supported by large wings, by slender legs, palmated feet, and a small hind toe. They are timid and cowardly, except in defence of their young. Generally seen in large flocks, the old and young separate; the larger species frequent the sea, the smaller, lakes or rivers. They walk with tolerable ease, and swim well, but are incapable of diving. They keep much on the wing, and their flight is rapid, strong, and long sustained, even in heavy gales. In sitting, they contract their neck, and rest on one foot. They are extremely voracious, fighting with each other for prey. They are patient of hunger, but will feed on every kind of animal food, either dead or alive, putrid or fresh. Their principal food, however, is fish, of which they will follow the shoals; they catch them with great agility, darting down like an arrow. They breed only once a year, laying from two to four eggs. The species are exceedingly numerous, and resemble each other greatly. The gulls are continually fighting with each other, and the strong plundering the weaker. No sooner does one rise from the water, with a fish in its bill, than it is immediately pursued by others, stronger than itself, and the first that reaches it tears away the spoil. Should, however, the latter not instantly swallow the booty it has acquired, it is, in turn, pursued by others; and, even if it has performed this process, it is oftentimes obliged to disgorge it, when it is seized by one of the pursuers, before it can reach the water. The facility which the gulls have of vomiting their food has been taken notice of, even in their captive state. Some of these birds have been tamed, but, even then, they have always discovered the same quarrelsome and voracious habits. When two are kept together, the weaker generally becomes the victim of the ill nature of the other. This genus is not well understood by naturalists, and much confusion exists as to the species.

GULLE. A peculiar liquid manure, in use in some parts of Holland, in several districts of Switzerland, and in the south-west of Germany. It is a dilution of the solid and fluid excrements of cattle in water, sometimes chemically affected by a foreign admixture, and always subjected, for a considerable time, to the putrefactive fermentation.

Gülle has been longest in use in Switzerland, particularly around the lake of Zurich; and is there prepared in trenches and tanks immediately connected with the cattle-houses. The floor on which the cattle stand is covered with planks, bricks, or tiles, and has a slight inclination toward their heels. A horizontal trench, for receiving their excrements, extends from end to end of the floor; and is formed of boards or walling, 18 inches wide and 24 inches deep; and is connected at its lower end with a covered tank, of 6 or 8 feet in depth. The trench is half-filled with water; the urine runs naturally into it; part of the solid excrements falls naturally into it, and the rest is raked and washed into it several times a-day; the straw-litter, which has become foul with excrement, is collected twice a week, and well rinsed in the trench with the dung-rake, and then left sufficiently long at the side of it to drip out the saturating liquid; and when the trench becomes quite or nearly full, its contents are first thoroughly stirred up, and then let out by the sluice at the end of it into the tank. The trench is again and again, or many times over, filled and emptied in the same way, till the tank becomes full; and in large establishments, the contents of the full tank, now in a state of considerable fermentation, are run off or pumped into a larger reservoir, and there kept, from four to six weeks, till they have become thoroughly fermented. The washed litter, after having been allowed completely to drip at the edge of the trench, is carried out of the house, and built up in regular quadrangular heaps; and it soon decomposes into a dark-brown fatty manure; but, in consequence of having been cleansed from nearly all the saline and nitrogenous principles of the dung and urine, this manure possesses comparatively little fertilizing power.

In the south-west of Germany, the tanks for the gülle are constructed in the fields, and supplied with water from adjacent springs; and both the urine and the dung are carried to them from the cattle-houses. The advantages of this method over the Swiss one, are the lessening of labour in carting the gülle to the fields, and, in some instances, the lessening of labour in conveying water to the farmery; and the disadvantages of it, are the increase of labour in collecting the excrements, and the dissipation of some portion of the ammoniacal principle before the excrements can be conveyed to the tank. A practice throughout the south-west of Germany, too, is to dissolve some copperas in the contents of the tank; and though this must damage ferruginous soils by adding to their proportion of iron, it delivers up its sulphuric acid into combination with the ammonia of the urine, and in consequence very generally gives a perceptible increase to the fertilizing power of the manure.

Gülle is generally applied as a top-dressing, and is found to be peculiarly suitable for grass-lands; but, on account of the labour of carriage, it can seldom be economically applied to fields or meadows at any considerable distance from the tank. A grand requisite for it is an adequate supply of water; and this requisite becomes a source of material enrichment, when the water holds a considerable quantity of saline matters in solution,—or, in popular phrase, is "very soft." Gülle is conveyed from the tank to the field in liquid manure carts; but it falls most equably and beneficially upon the soil, when made to flow from an aperture in the centre of the lower side of the barrel, and to splash upon a dispersing-board suspended below the aperture. In pumping it out of the tank into the barrel, care ought to be used to leave behind all the undecomposed vegetable fibre lying as sediment at the bottom of the tank; for, when this is mixed with gülle used as top-dressing, it lies on the leaves of the young plants, and produces an injurious incrustation. And it ought always to be applied, either in a state of comparatively great dilution, or when the soil is much moistened with rain; for if used upon dry grass-land in the concentrated form in which it is prepared, it will act in a somewhat caustic manner, and probably do more harm than good.

Dr. Sprengel, to whose treatise on Manures we are indebted for the facts we have now stated, speaks very highly of gülle, and strongly recommends it to the attention of farmers. "Although," says he, "the arrangements of the cattle-stalls, as well as the numerous tanks, required in the preparation of the gülle, in order to preserve it for the proper period, occasion much expense, and likewise its distribution over the field much labour, these outlays are richly repaid in the advantages derived from this manure, as will be more clearly shown under the following heads:—1. The water, which is constantly kept in the trench, absorbs much of the carbonic acid given out by the cow in the act of breathing, and consequently the ammonia arising from the urine is not only neutralized and thus rendered less volatile, but the carbonic acid is also in itself a strong manuring substance. 2. The water in the trench serves to keep the cow-house cool during the heat of summer, and the vapour occasions a dampness in the atmosphere, which is much better for the health of the cow than a hot and dry air. 3. Little, or perhaps none, of the ammonia, developed by the urine is lost; its escape being prevented, as my own experiments on the putrefaction of urine and water have proved, by the large quantity of water present. The absolute gain of manuring element from this circumstance, is, indeed, very considerable, and fully confirms the statement of the Swiss, that, since the time of the introduction of gülle, agriculture has been considerably improved. 4. By means of the gülle, a sickly plant derives almost immediate relief, in consequence of all the nutriment being already dissolved by the water, and in a fit state to enter at once into the plant. 5. It is a point of particular importance that, in adopting the use of gülle, a quicker return on outlay of capital is obtained than in the case of common yard-manure. 6. From the gülle little or none of the manuring matter is carried off by the rain, while from yard-manure it frequently happens that much is so lost; the practice of spreading it on the field in heavy dressings causing its action to continue during three or four years, or even longer. 7. By means of the gülle, plants may be brought with most certainty to the exact degree of luxuriancy which will yield the most abundant produce. 8. The growth of forage plants, particularly of clover and the meadow grasses, is greatly secured by the application of gülle, particularly when (as they do in the Black Forest) we add green copperas to the putrefying gülle, and the stall-feeding of cattle in summer is made more practicable. 9. In adopting the preparation of gülle, less litter will be required. When cattle are not properly bedded, much of the manure escapes in the form of gas, while by mixing the excrement with a large quantity of water little or none of it is lost: it is consequently evident, that, in the preparation of gülle, a greater quantity of manure is gained than in that of common yard-dung; and what is the most important point is, that the gülle has retained a larger proportion of that very substance which has the most important influence in the nourishment of plants, namely, ammonia. In fact, all the advantages derived from the preparation of gülle are so important, that we cannot but wish comparative experiments may be made, in order to ascertain with more certainty what is the real amount of gain in its adoption. It might, perhaps, be useful also to prepare gülle from horse and sheep dung, as, under the present management of these manures, far more ammonia is lost by evaporation than in the case of cattle-dung."

GUM. One of the proximate principles of vegetables, distinguished by the following properties:—It is an insipid, inodorous, uncrystallizable solid, more or less transparent, the various colours which the different kinds possess being derived from mixture with colouring principles while exuding in a fluid state. It is insoluble in alcohol, and extremely soluble in water, in which properties it is the reverse of resin. It differs from mucilage only in being deprived of the water which rendered it fluid; and, of course, when water is added, it again becomes mucilage. This mucilage is apparently not susceptible of fermentation, and may be kept for a long time, as it is less disposed to spontaneous changes than almost any vegetable product. Its chemical composition so nearly approaches sugar, that it may be converted into it by means of nitric acid. Gum, as above defined, is identical in all vegetables, and the different kinds vary only in the quantity and quality of the substances united with them. It exists naturally almost pure in gum-Arabic and gum-Senegal, and, more or less mixed, in the gum which exudes from the plum, cherry and other fruit-trees, as also in the mucilage of flaxseed, slippery elm, &c. Various resins and gum-resins are commonly confounded under this appellation.

GUM. A kind of canker in trees, particularly in fruit-trees. See the article CANKER.

GUMS. The fleshy and sheathing socket of the teeth of animals. See the articles TOOTH and AGE OF ANIMALS.

GUM-ARABIC or GUM-ACACIA. The gum of several varieties and species of trees, of the acacia genus. The species which yields the best gum is the *Acacia Arabica;* and this was introduced to the hothouses of Britain from India in 1820. See the article ACACIA. But the species which produces the greatest proportion of the gum of commerce is the *Acacia gummifera;* and this was introduced to Britain from Guinea in 1823. Its stem is crooked, and rises sometimes to the height of 40 feet, but generally to the height of only a few feet; its bark is grey on the stem, and purplish on the branches; its leaves are alternate and bipinnate, each comprising from 6 to 8 pairs of opposite leaflets; two long, white spines diverge from beside the base of the leaves; the flowers are yellow, and grow in crowded, globular, peduncled heads; and the pods are 3 or 4 inches long and ½ an inch broad. The whole plant has a harsh and withered appearance. The gum exudes naturally from the stem and branches, and hardens in the air. Pure specimens of it are almost colourless or of a pale whitish-yellow tint; and are tasteless and odourless; and dissolve away slowly but completely in the mouth. The gum of commerce, however, is exceedingly various, both in natural quality and in comparative purity. Three great varieties of it, each comprising many shades of quality, are familiarly known,—true Gum-Arabic, in whitish, roundish, cracked, and brittle pieces,—Gum-Gedda, in brownish-red, comparatively long, and not very brittle pieces,—and Gum-Senegal, in comparatively large, pellucid, round, uniform pieces, of various colours from white to red. Gum-Arabic is used in both human and cattle medicine; yet it performs no medicinal action on the system; but serves simply to lubricate abraded surfaces, to allay tickling irritation, to act generally as a demulcent, and to form emulsions, to hold insoluble powders in equable mucilaginous mixture, and to render oils mechanically combinable with water. Emulsions made with it are supposed to act favourably in affections of the urinary system.

GUM-CISTUS. See CISTUS.

GUM-RESINS. Substances which apparently combine the properties of gums and resins, being partly soluble in water, partly in alcohol; but they are evidently compound substances, formed of two or more vegetable principles, which, indeed, are often in a state of mere mechanical mixture. Aloes, ammoniac, asafœtida, galbanum, gamboge, olibanum, scammony, and a great variety of concrete juices, are referred to this head.

GUM-TREE. See EUCALYPTUS.

GUSTAVIA. A small genus of ornamental plants, of the myrtle tribe. The august species, *G. augusta*, is a magnificent, white-flowered, evergreen, tall shrub, of tropical America; and was introduced about 50 years ago to the hothouses of Britain.

GUTTA-PERCHA. A recently discovered substance, of similar but superior properties to caoutchouc. The plant which yields it is a tree of Malacca, Borneo, and probably most of the islands of the Indian Archipelago. It usually has a diameter of 3 or 4 feet, but sometimes attains a diameter of 6 feet; but it has no value as a timber tree. Its milky juice, soon after being drawn from it, coagulates in the air, and constitutes gutta-percha; and it has hitherto been obtained by the wasteful and exterminating method of felling the tree, stripping off the bark, and collecting the juice in a plantain-leaf trough; but it might probably be obtained with equal ease by tapping. A felled tree, of from 50 to 100 years' growth, yields from 20 to 30 lbs.

Gutta-percha is unknown or unappreciated in many places where the tree grows; and seems, till quite recently, to have been unappreciated everywhere, and for all purposes, except by a few Malays for making handles, instead of wood or buffalo-horn, to their parangs or wood-choppers. But it was introduced a few years ago to Europe; and has already become an extensive article of commerce, and a much valued material in many departments of the useful arts. It has the important property of dissolving without being volcanized; it becomes as plastic as clay when dipped in boiling water, readily assumes any shape or figure impressed upon it, and fully retains its new form in returning to a state of hardness and rigidity; it takes a clear, sharp impression, and is both tough and durable; it serves well for making those parts of surgical instruments which were formerly made of caoutchouc; it will probably be found eminently suitable for making raised types and embossed maps for the blind; and, in a purified state, it combines in many proportions with some other substances to form a variety of very valuable materials for the arts.

A patent for improving the manufacture of gutta-percha was taken out a short time ago by Mr. C. Hancock. It is generally imported in a state of considerable impurity; and may, according to Mr. Hancock's statement, be purified by passing it through a screw press, or by melting and straining it, or by dissolving it in rectified oil of turpentine, filtering the liquid through felt or flannel, and driving off the solvent by evaporation. But during purification, it ought to be maintained at such a temperature, as shall leave it in a plastic state, and of the consistency of dough or putty. Mr. Hancock combines gutta-percha with caoutchouc and jintawan, to form an elastic material impervious to water; and he varies the proportions so as to produce any degree of hardness or elasticity which may be required,—a larger proportion of gutta-percha producing hardness, and a smaller proportion producing elasticity; and when extreme hardness is required, the process can be so conducted and prolonged as to produce a material which will bear the lathe like hardwood or ivory. A mixture of 50 parts of gutta-percha, 24 of jintawan, 20 of caoutchouc, and 6 of orpiment, is used for making elastic bands; another mixture produces a light, spongy, porous material, suitable for chair-bottoms, cushions, mattresses, saddles, and similar objects; another mixture is suitable for belts, garters, clasps, and clock-springs; and others are suitable for door-handles, picture-frames, walking-sticks, chess-pieces, buttons, combs, flutes, and a great number of other useful and ornamental articles. Gutta-percha first came into commercial notice in 1842; and it has since been imported from Singapore at the rate of several hundred tons a-year; but if the present destructive method of gathering it continue to be practised, it must eventually, and perhaps soon, rise in price and become stinted in quantity.

GUTTA SERENA. See AMAUROSIS.

GUTTER. A small and narrow surface drain. But the word is used in a restricted and technical sense in the practices of irrigation. See the article IRRIGATION.

GUT-TIE. See CORDS.

GUTTIFERÆ. A natural order of tropical shrubs and trees. They are popularly recognised, and very easily distinguished, by their resinous exudations, and their opposite, entire, thick leaves; and they possess great economical value in the countries where they grow. All have beautiful foliage and showy flowers, and are suitable for ornamental culture in large hothouses. About 30 species, belonging to 11 genera, have been introduced to Britain.

GYMNADENIA. A genus of beautiful, hardy, tuberous-rooted plants, of the orchis tribe. The name gymnadenia signifies "naked gland," and alludes to the appearance of the stem of the pollen masses. The gnat-like species, *G. conopsea*, was included by the older botanists in the original orchis genus; and it takes its name of gnat-like from the appearance of the flower. It is a native of the meadow-lands of Britain; its stem has a height of 10 or 14 inches; and its flowers are purple-coloured in the normal plant, and white-coloured in a permanent Scottish variety, and bloom in June and July.—The green species, *G. viridis*, is also a native of the meadow-lands of Britain, and is popularly called the frog orchis; and was called by Linnæus *Satyrium viride*. Its stem is 9 or 10 inches high; and its flowers have a green colour, and bloom in June and July.—The small white species, *G. albida*, grows wild in the warm, south-exposed hill-pastures of some parts of Britain. Its stem is 5 or 6 inches high; and its flowers are whitish, and bloom at midsummer.—Three or four species have been introduced from Continental Europe and western Asia.

GYMNEMA. A genus of ornamental, evergreen, twining tropical plants, of the swallow-wort tribe. Several species, of naturally 8 or 9 feet high, have been introduced from India to British hothouses; but they are very closely akin to the true swallow-worts.

GYMNOCLADUS. See BONDUC (HARDY).

GYMNOGRAMMA. A genus of very beautiful, evergreen, tropical ferns. About a score of species, some of them eminently handsome, have been introduced to our stoves from the West Indies, and tropical America; and a considerable number more are known. The lower surface of the fronds of some is hairy, and that of the fronds of others is mealy; and the sori or clusters of spores of all are naked, and are alluded to in the name gymnogramma.

GYMNOLOMIA. A genus of beautiful, yellow-flowered, tropical, evergreen shrubs, of the sunflower division of the composite order. The spotted species, *G. maculata*, has a height of 3 or 4 feet, and blooms at midsummer; and the three-nerved species, *G. triplinervia*, has about the same height, and blooms in the end of autumn and beginning of winter; and both of these were introduced to Britain upwards of 20 years ago.

GYMNOSTOMUM. A genus of moss plants, forming the type of the suborder gymnostomi. The chief members of this suborder are the true gymnostomums and the box-mosses or sphagnums. The name gymnostomum signifies "naked mouth," and alludes to the orifice of the theca. About 20 species of true gymnostomums are indigenous in Britain; and nearly 30 more are known. Most of the indigenous ones have a height of from ½ an inch to 1½ inch; and some grow in tufts, others in little spots, and others in broad patches,—some in grass fields, others on banks and waste grounds, and others on wet rocks,—and some are conspicuous in spring, others in summer, and others throughout the year. But the twisted species, *G. tortile*, an inhabitant of wet rocks, grows 9 or 10 inches high.

GYNANDRIA. See Botany.

GYNANDROPSIS. A genus of ornamental plants, of the caper-tree family. Seven or eight species have been introduced to Britain; and several more are known. Three of the introduced species are hardy, white-flowered, or white and purple-flowered annuals, of about a foot in height; another is a half-tender, red-flowered annual, of about the same height; and the others are tender, white-flowered annuals and biennials, of considerably greater height: and all were formerly included in the genus cleome.

GYPSOCALLIS. See Moor-Heath.

GYPSOPHILA. A genus of hardy, herbaceous, ornamental plants of the carnation order. About 30 species have been introduced to Britain, principally from continental Europe and western Asia; and ten or twelve more are known. Five of the introduced species are annuals; four are creeping perennials; and the rest have perennial roots and upright annual stems. Most are about a foot high; but some are only a few inches, and others are from 1½ to 4 feet. About one half have white flowers; and most of the others have some shade of red, between the lightest flesh colour and light crimson. One of the longest known was introduced upwards of a century ago from Spain; and has narrow, pointed, recurved root-leaves,—narrower and opposite stem-leaves, —clusters of still smaller leaves at some of the stem-joints,—and a system of small branches, diverging from the upper part of the stem, and each terminating in a close bunch of small white flowers. All the species adorn the open border of the flower-garden.—Gypsophila is also the specific name of a handsome, white-flowered, perennial-rooted, half-foot-high catchfly. The name gypsophila means "the love of chalk," and alludes to the fondness of the plants for a calcareous soil.

GYPSUM. The hydrous sulphate of lime. It consists of 40·1 per cent. of sulphuric acid, 28·5 of lime, and 18 of water, or of three equivalents of sulphuric acid, one of lime, and two of water, or of one equivalent of sulphate of lime, and two equivalents of water. It can easily be artificially formed by mixing a solution of muriate of lime with any soluble sulphate, or by pouring sulphuric acid upon common quicklime. In the latter case, a violent heat is evolved, and, when the mixture is ignited, water is given off; and if the sulphuric acid have been in sufficient quantity, the resulting substance is all gypsum,—and, if not, the substance is partly gypsum and partly quicklime.

Properties and Varieties of Gypsum.—Gypsum is soluble in about 500 times its weight of cold water, and is more soluble in hot water; and when dissolved in the latter, or boiled in it to solution, it deposits itself in crystals as the water cools. A solution of it affords precipitates to solutions of oxalates and of barytic salts; and the crystals of it are generally flattened prisms, with a rhombic prism for their primary form. Pure crystallized gypsum is frequently called selenite; and the hard, white, compact variety of it, used in statuary, is called alabaster. See the article Alabaster. Gypsum deprived of its water by a low red heat becomes a fine powder, and constitutes Plaster of Paris; and it took this name from the circumstance of its occurring in great abundance, as a geognostic formation, around the metropolis of France. Plaster of Paris is everywhere well known as a cement, and as the material of stucco casts and of multitudes of stucco ornaments; and it owes its useful properties, in these respects, to its solidifying affinity for water, or to its forming with it a firm, coherent, homogeneous mass. Pure sulphate of lime, in its proper mineral condition, is called anhydrite; it has scarcely any taste; it has been commonly thought to sustain a white heat without undergoing any decomposition, but has been shown by Dr. Thomson to part with some of its acid when heated to redness; and it is considerably more soluble in water than the sulphate of baryta or the sulphate of strontia. Gypsum more or less impregnates the water of many springs, and gives it the property which is popularly called hardness.

Where Gypsum is Found.—Gypsum is one of the abundant minerals on the surface of the earth. It is an ingredient, though not a bulky one, in very many soils; it occurs so plentifully in substrata as to impregnate the water of very many springs; and it exists in the crystalline state, and in granular and fibrous masses, in the geognostic strata of most recent formation, and particularly in the districts of the newer limestones. The specimens of it in Shotover Hill near Oxford are quoted by Sir Humphrey Davy as examples of it in its normal state. The specimens in Derbyshire and Nottinghamshire are, in many instances, so fine and compact as to take the rank and serve the purposes of alabaster. Specimens of it, in great plenty and in considerable variety, have long been known in France, Saxony, Spain, Italy, and other parts of Europe. But the gypsum of commerce has generally in combination with it some proportion of silica, and of carbonate of lime. English gypsum is usually sold in Hampshire at about 1s. 9d. per bushel; it is still cheaper in the midland counties; it is so very abundant in Derbyshire as to be commonly used for making the floors of farmers' cheese-rooms; and it is more or less abundant also in Oxfordshire, Gloucestershire, Somersetshire, the northern Counties, and several other parts of England.

History of Gypsum as a Manure.—The grand value of gypsum to the farmer, and even the chief interest of it to the merchant, are its uses as a manure. Virgil, in commending the use of ashes to the Roman farmers, speaks of the value of a very impure variety of gypsum; and the early inhabitants of Britain, and the farmers of Lombardy, made use of it in some such way as the Romans. But none of these parties were acquainted with its real nature; and even the chemists, till a comparatively late period, were unable to distinguish it from limestone or other calcareous substances. About the middle of the 18th century, a substance which was long afterwards shown to be an impure gypsum, which had been used as a fertilizer in the neighbourhood of Hanover, drew the attention of Mayer, a talented Protestant pastor in the principality of Hohenlohe, and was found by him to possess such manurial powers as promised to be of great and general service to agriculture. He recommended and published the substance by both example and writing; and he speedily made a deep and extensive impression in its favour. Many agriculturists subjected it to experiment; and Schubart in Germany, Tschiffeli in Switzerland, and Franklin in America, wrote in recommendation of it, pushed it into notoriety, and both won for it a host of friends, and provoked against it a host of foes.

The use of gypsum extended rapidly in various parts of Europe, particularly in the district around Paris; and was so zealously propagated in North America as to occasion exportations from the quarries of Montmartre to the western side of the Atlantic; and gypsum rapidly obtained the fame, in both the old world and the new, of being one of the most powerful auxiliaries of vegetation. But the opposers of it were many and formidable; and among the most strenuous of these were the proprietors of the salt-pans, who maintained that schlot or the refuse of their pans was the only true fertilizer of its class, and could never be superseded or competed with by gypsum; and yet this very schlot turned out, in a maturer state of mineral analysis, to be itself an artificial gypsum, of precisely similar constitution and action to the natural gypsum of the quarries. The advocates of gypsum, however, were, in a sense, its worst enemies; for they so exaggerated its powers, and spoke of it as an universal manure, and recommended it for all sorts of manurial purposes, as necessarily to produce great disappointment, and in consequence provoke disgust, anger, and opposition. Experience eventually, though slowly and hesitatingly, assigned very distinct and somewhat confined limits to its fertilizing power; pronounced it to require, in every case, the co-existence with it in the soil, either naturally or artificially, of organic manures; declared it to be efficacious chiefly on soils rich in humus and poor in salts, and generally to but a small number of ordinarily cultivated plants, such as lucern, sainfoin, clover, ryegrass, turnips, and the grasses of artificial meadows; and condemned it as almost or altogether worthless to cereal crops, to the greater number of hard crops, and to most kinds of natural grass lands. Opinions were very long divided, too, respecting the seasons and methods of applying it; particularly as to whether it should be pulverized and applied in its natural state or first burned and then pulverized, and as to whether it should be sprinkled on the surface as a top-dressing or thoroughly intermixed with the soil. In many and extensive districts, also, whose soil has since been supposed to contain a sufficient natural intermixture of gypsum for all the purposes of vegetation, the application of the new manure, no matter how or when made, was found to produce no beneficial effect whatever upon any kind of ground or crop.

"The opinions of practical men, with regard to the advantages and propriety of applying gypsum," says Boussingault, "although they agreed in certain determinate circumstances, were still far from being unanimous. A particular inquiry into the subject was therefore held worthy of its attention by the French government, and a comprehensive report on all the information collected was made by M. Bosc to the Royal Central Agricultural Society of France. This report shows in a striking manner the advantages that may be derived from the lights of practical men; in a single line or sentence, we frequently find a summary of 20 or 30 years' experience. The following series of questions and answers I believe to embrace most of the points of any interest connected with the employment of gypsum. 1st. Does plaster act favourably on artificial meadows? Of 43 opinions given, 40 are in the affirmative, and 3 in the negative. 2d. Does it act favourably on artificial meadows, the soil of which is very damp? Ten opinions given; unanimously, no. 3d. Will it supply the place of organic manure? or will a barren soil be converted into a fertile one by the use of it? Seven opinions given; unanimously, no. 4th. Does gypsum sensibly increase the crops of the cereals? Of 32 opinions, 30 were negative, and 2 affirmative." Some subsequent experiments, judiciously planned and carefully executed by Mr. Smith in England and M. de Villèle in France, as well as other experiments of a less prominent character by other distinguished agriculturists, have drawn a very distinct limit round the manurial utility of gypsum, and fully ascertained the conditions in which its fertilizing power is developed.

The Methods of using Gypsum as a Manure.—Gypsum, when used as a manure, ought to be ground and applied in its natural state; for it has been proved by abundant experience to acquire no increase of power from burning or from any other known preparational process than simple pulverization. It is usually sown or sprinkled upon the surface of meadows; but, though it acts well enough when applied in that way, it acts still better when incorporated with the soil. It is generally believed to act peculiarly well when sprinkled under such conditions as to make it lie like a film upon the wet leaves of the growing plants; but it probably derives all the advantages of that mode of deposition from the equality with which it is distributed and retained athwart the surface. Yet whenever used as a top-dressing, it ought certainly to be applied in calm moist weather, and will be all the more successful if applied at the particular time in spring when the young plants of lucern or sainfoin or clover have already made some degree of progress. "I have noticed, in applying gypsum to grasses," says Mr. Johnson, in his Prize Essay in the Royal Agricultural Society's Journal, "that the weather at the time of spreading it has a very material influence upon the result of the experiment. Its effects are never soon apparent when it is sown in dry weather; but if the season is damp, so that the white powdered gypsum adheres to the leaves and stalks of the young grass, the good effect is then immediate. This observation was made, many years since, by Arthur Young, by Mr. Smith, and by the American farmers: it is a well-known fact with the sainfoin-growers of the Berkshire and Hampshire chalk formations, the clover cultivators of the gravels and loams of Surrey and Kent, and on the lucern grounds of the alluvial soils of Essex and Middlesex. The farmers of the United States, when dressing their turnips with gypsum, always found it answer best when spread in rainy weather."

The Crops which Gypsum fertilizes.—The highly fertilizing power of gypsum upon sainfoin, and some of the circumstances which modify it, were well ascertained by Mr. Smith's experiments in three years of the last decad of last century. The soil on which the experiments were made was a light vegetable earth, 3 feet deep at the upper end of the field, and gradually lessening to 3 inches at the lower end, and everywhere incumbent on a subsoil of chalk; and the field was divided into equal breadths for gypsed and ungypsed growths of sainfoin, with every precaution that the circumstances should as nearly as possible be equal. In one experiment, the crop on the deeper ungypsed soil amounted to 3,357 lbs. of the dry herb, and 419 lbs. of seed; while that of the contiguous breadth, which had received about 15 bushels of gypsum in the spring of 1794, amounted to 5,462 lbs. of the dry herb, and 582 lbs of seed. In another experiment, the crop on a shallower and ungypsed part, amounted to 2,766 lbs. of the dry herb, and 245 lbs. of seed; while that upon the contiguous part, which had received about 15 bushels of gypsum in the spring of 1792, amounted to 4,381 lbs. of the dry herb, and 379 lbs. of seed. In a third experiment, the crop on the shallowest part, ungypsed, amounted to 2,068 lbs. of the dry herb, and 66 lbs. of seed; while that upon the contiguous part, which received about 15 bushels of gypsum in the spring of 1794, amounted to 4,879 lbs. of the dry herb, and 211 lbs. of seed,—and that upon the same part, gypsed with 15 bushels also in the spring of 1792, amounted to 4,310 lbs. of the dry herb, and 205 lbs. of seed. Thus the crop from the ungypsed breadth being taken as 100, that upon the gypsed breadth is 231,—it is more than doubled. But on comparing the weight of the herbaceous portion with that of the seed, widely different relations are apparent; for the proportion of herb to seed in the ungypsed portion of the first experiment was as 100 to 12·5, in the gypsed portion of that experiment as 100 to 10·7,—in the ungypsed portion of the second experiment as 100 to 8·9, in the gypsed portion of that experiment as 100 to 8·7,—in the ungypsed portion of the third experiment as 100 to 3·2, in the once-gypsed portion of that experiment as 100 to 4·3, and in the twice-gypsed portion of that experiment as 100 to 4·8. Both without and with gypsum, therefore, the proportion of the seed to the herb falls rapidly off from the deep soil to the shallow. Some principle essential to fructification was hence supposed by Mr. Smith to be very deficient in shallow soil; and this principle, in all probability, is some portion of the compound product of decomposed and decomposing organic matter.

The fertilizing power of gypsum upon white clover, was ascertained by Mr. Smith to be still greater than upon sainfoin. He applied the gypsum in connexion with this crop, in the proportion of 6 bushels per acre, at an advanced period in May, when the clover looked pale, and seemed to want sap; and only a fortnight afterwards, though no rain fell in the interval, the clover was vigorous, and began rapidly to form so thick a covering as to protect the ground from an intense sunshine, which scorched every adjacent ungypsed spot. In one experiment, the ungypsed crop amounted to 839 lbs. of the herb and 56 lbs. of seed, while the gypsed crop amounted to 2,226 lbs. of the herb and 316 lbs. of seed; and in another, the ungypsed crop amounted to 500 lbs. of the herb and 61 lbs. of seed, while the gypsed crop amounted to 2,270 lbs. of the herb and 174 lbs. of the seed. The mean of these experiments shows the increase from gypsing to have been as 225 to 100.—M. Villéle's experiments do not show so largely; yet, in consequence of having been made on moist, stony, clayey soil, of about 16 inches in depth, and incumbent on a stiff clay subsoil, they are quite as decisive and considerably more interesting. In one of his experiments, gypsum was applied in the proportion of 4 cwt. per acre, and the ungypsed dry crop amounted to 20 cwt. 1 qr. 23 lb., while the gypsed dry crop amounted to 40 cwt. 3 qr. 19 lb.; and in another, gypsum was applied in the proportion of 5¾ cwt. per acre, and the ungypsed dry crop amounted to 19 cwt. 2 qr. 16 lb., while the gypsed dry crop amounted to 32 cwt. 2 qr. 27 lb.—So far as past experience discloses, gypsum may perhaps be pronounced less variably and more certainly beneficial to clover than to any other agricultural plant; and it has often the curious property of materially benefiting clover in such a manner as to render the effect observable only when the crop is converted into hay. "I have tried gypsum on a great variety of soils," says Dr. Shier, "in general with but little success. In a few instances, however, it proved highly beneficial to clover. In these cases I observed that the advantage could not be detected by the eye, or even by the balance, when the produce was weighed green, but it was very apparent on weighing the dried hay."

The fertilizing power of gypsum upon leguminous plants, as a class of vegetables, refers generally to their herbage, and has seldom any connexion with their seeds. Any inference which might be drawn from the suitableness of gypsum for sainfoin and clover to the suitableness of it for pease and beans, would be a total and ruinous mistake. Any leguminous plants whose seeds are used for food, and which are grown upon soil either naturally or artificially capable of yielding to them even a very small proportion of sulphate of lime, usually assimilate so much of this salt into their seeds that these cannot easily be softened by boiling. The stubborn hardness of some pease and beans is frequently ascribed by cultivators to the temperature of the season of growth, or to the rains which fall at the time of harvest, but is really caused by the assimilation of gypsum, and may be readily corrected by throwing a little subcarbonate of soda into the water in which they are boiled. But when leguminous plants are grown entirely for the sake of their herbage, and especially when they are intended to form a perennial cropping of green fodder for cattle, the enriching of the soil with gypsum gives them great energy of vegetation, and causes them to push forth very succulent leaves, and to renew for a long time the stems which are cut for fodder.

Some statements say that gypsum is usually very beneficial to turnips; and others assert that it is more uniformly successful for potatoes than for any other field crop. We have no means of decidedly affirming or denying these statements, or of recording the particular conditions under which they may be correct. But an unsuccessful experiment upon the gypsing of mangel-wurzel by Boussingault, may probably be regarded as indicative of the general inutility of gypsum to root crops. "The plants," says he, "were transplanted and watered, and the gypsum was applied at the time of earthing up. A good deal of rain fell; and shortly after having been laid on, the gypsum became incorporated with the ground. The crop was gathered on the 8th of October, three months after the gypsing, and from two equal surfaces, each of 242 square yards in extent, weighed as follows:—from the gypsed ground, 13 cwt. 2 qr. 6 lb.; from the ungypsed, 12 cwt. 2 qr. 3 lb. The gypsum would therefore appear to have had no beneficial effect; for the difference in favour of the gypsed piece is so trifling, that it cannot be reasonably ascribed to the mineral manure; in fact, the quantity obtained from the gypsed surface does not exceed that which we constantly take from fields in the ordinary course of cultivation, and which have received no gypsum."

The fertilizing power of gypsum upon the cereal crops, as we formerly saw, was denied in 30 out of 32 answers to the Royal Agricultural Society of France, and affirmed in only 2. This ought to be decisive; yet it is hindered from making a due impression by a statement that, in the experiments of Smith, gypsed land as compared to ungypsed land produced grain in the proportion of 192 to 100. A doubt is thus started, which requires to be laid to rest; and it may be dealt with by an appeal to the recent experiments of Boussingault. He tried gypsum on wheat after ploughed-in clover, after mangel-wurzel, and after potatoes, all in 1842; and the results in the entire produce were,—after the ploughed-in clover, 319 lb. on the gypsed piece, 323 lb. on one ungypsed piece, and 327 lb. on another ungypsed piece,—after the mangel-wurzel, 195 lb. on the gypsed piece, 176 on one ungypsed piece, and 158 on another ungypsed piece,—and after the potatoes, 235 lb. on the gypsed piece, 245 lb. on one ungypsed piece, and 264 on another ungypsed piece,—thus giving an average, on the three experiments, of 250 lb. on the gypsed piece, 248 lb. on one ungypsed piece, and 250 lb. on another ungypsed piece. But as the long drought of 1842 was unfavourable to wheat, other experiments were made in the eminently favourable year, 1843, on equal areas of 385 square yards each, with a dose of 70 lb. of gypsum on each of the gypsed areas; and the results were as follow:—Rye with gypsum, 516 lb. in sheaves, and 137 lb. of grain; rye without gypsum, 472 lb. in sheaves, and 127 lb. of grain. Oats with gypsum, 329 lb. in sheaves, and 112 lb. of grain; oats without gypsum, 368 lb. in sheaves, and 113 lb. of grain. Wheat with gypsum, 462 lb. in sheaves, and 147 lb. of grain; wheat without gypsum in one place, 453 lb. in sheaves, and 143 lb. of grain; wheat without gypsum in another place, 510 lb. in sheaves, and 156 lb. of grain.

The fertilizing power of gypsum upon the artificial grasses, except in cases where the soil naturally contains a sufficient proportion of sulphate of lime, is well-ascertained, and of great practical value. This is particularly true with respect to the usual rotational mixture of clover and ryegrass. "If the farmer finds," says Mr. Johnson in his Prize Essay, "that his fields will only grow clover successfully once in 8 or 12 years, and that his neighbours tell him his land is 'tired' of clover or 'clover-sick,'—if he notices that even the application of farm-yard compost hardly adds to the luxuriance of his grasses, he may then safely conclude that his crops have gradually exhausted his land of sulphate of lime,—and he may, with every confidence of success, apply a dressing of gypsum, at the rate of 2 cwt. per acre, taking care to choose a wet morning for the application; and this may be done at any season of the year, but it is best either in April or the first days of May." He then declares that he can attest these facts from experience and observation; and narrates two remarkable verifications of them, in the case respectively of an old paddock, and of clover and sainfoin lands. The paddock was old, and had gradually become less and less productive; and, after being vainly plied with many kinds of mineral and compost manures, a portion of it suddenly became luxuriant under a dose of 40 bushels per acre of peat-ashes, containing 12 per cent. of sulphate of lime, and otherwise consisting of sand, chalk, red oxide of iron, and a small quantity of common salt; and when suspicion arose that this revived portion owed its revival solely to the sulphate of lime, another portion was dosed with finely pulverized gypsum, at the rate of 2 cwt. per acre, and experienced fully as great a revival, not only sending up its former grasses with renovated vigour, but producing white clover and other grasses, whose seeds had long been sleeping in the soil. The soil of the paddock contained 6½ per cent. of organic and soluble matters, and 19 per cent. of carbonates of lime and magnesia, and was about 10 inches deep, and rested on a thin stratum of gravel, immediately incumbent on chalk. The experimenter in the case of the clover and sainfoin lands, Mr. Barnard of Little Bordean in Hampshire, says, "I have sown gypsum 6 or 7 years, and never on clover or sainfoin without satisfactory proof of its efficacy, having usually grown half a ton or more of hay per acre by its use;" and he adds that, on the 1st of May, 1838, he gypsed a piece of a field of two-year-old sainfoin at the rate of 2¼ cwt. per acre,—that, at harvest time, he reaped from it a produce of hay quite one ton per acre extra,—that in October, he reaped from the gypsed portion another produce of 1¼ ton per acre, while there was scarcely any on the ungypsed portion,—and that, in the following year, without making any new application of gypsum, he got two mowings from the gypsed portion, and could find nothing to cut on the ungypsed portion.

An incidental verification of the fertilizing power of gypsum upon the artificial herbage-plants, similar to that afforded by the instance of the peat-ashes, occurs in the common and successful use of coal-ashes as a top-dressing for clover, lucern, and sainfoin. Such coal-ashes as are found on analysis to contain a considerable proportion, say about one-tenth of their whole weight, of sulphate of lime, are generally found by farmers to be the most efficacious top-dressing for these plants which they can apply; and as they otherwise comprise but a very small proportion of fertilizing substances, they may be inferred to owe all or very nearly all their efficacy to their gypsum. A fact of considerable interest in reference to gypsed grass-lands, too, is that horses and cattle always prefer the grass of a gypsed portion of a field to that of an ungypsed portion. But let not any farmer be induced by these considerations to throw away money and labour in the gypsing of any ordinary natural pastures. "It is certain," says Boussingault, "that gypsum has no effect upon natural meadows. Positive experience has satisfied me of the absolute inutility of the substance here; so that upon my natural meadows at Bechelbronn I now never employ a particle of it."

Theories of the Fertilizing Action of Gypsum.—The fertilizing action of gypsum was ascribed by some of the agriculturists of last century to its alleged capacity for absorbing moisture. But when combined with water, it actually solidifies that liquid, or at least retains it too tenaciously to permit the surrender of any of it for the uses of plants; and so far as it does not combine with water, it has an exceedingly limited capacity for moisture, and cannot possibly absorb enough of it to be of any material service to vegetation. But even though it could act as an absorbent, it is applied in much too small a quantity for the wants of a crop; and it would be of as much use to many other agricultural plants as to the few on which it is known to act; and it would exert its powers only during brief periods immediately succeeding the fall of rain. Quicklime, too, imbibes water far more eagerly than gypsum does; and yet it acts upon plants with far less striking effect.

The fertilizing action of gypsum was ascribed by other agriculturists of last century to its supposed power of accelerating the decomposition of organic manures, and assisting the putrefactive fermentation of animal substances. But gypsum really possesses no such power. "I have tried some experiments on this subject," says Sir Humphrey Davy, "which are contradictory to the notion. I mixed some minced veal with about one-hundredth part of its weight of gypsum, and exposed some veal without gypsum under the same circumstances; there was no difference in the time in which they began to putrefy; and the process seemed to me most rapid in the case in which there was no gypsum present. I made other similar mixtures, employing in some cases larger, and in some cases smaller quantities of gypsum; and I used pigeon's dung in one instance instead of flesh, and with precisely similar results. It certainly in no case increased the rapidity of putrefaction." Gypsum, besides, is known to fertilize lands which, at the time of its application, contain very little animal manure; and if it derived its power from being a decomposer of dead organic substances, it would, contrary to all experience, act beneficially in all sorts of tillage soils and for all kinds of tillage crops. Yet one important fact—whether due to a solvent power of gypsum upon vegetable organic matter in an advanced stage of decomposition, or to some interchange of action between the sulphuric acid of the gypsum and the several acids within the soil, or to one or more actions referred to in other theories—is, that it exerts its highest fertilizing power on land very rich in humus, and becomes comparatively feeble in land which contains little mould.

The fertilizing action of gypsum is ascribed by Sir Humphrey Davy and by some of the leading agriculturists of the present day to its mere absorbability by plants, or to its properly forming an element in their food. Sir Humphrey found a large proportion of sulphate of lime in the ashes of vegetables grown on soil which had been treated with ashes abounding in the substance; and he believed that gypsum entered particularly into the constitution of the woody fibre. Mr. Johnson also reminds us that an ordinary crop of clover or sainfoin, according to the proportions of their principles ascertained by analysis, usually contains from 1½ to 2 cwt. per acre of sulphate of lime; and remarks that this is precisely the quantity of the dose of gypsum which the best cultivators have found to produce a maximum benefit on the soil; and he suggests also, that the proportion of sulphate of lime found in certain plants may be as essential to their growth as the presence of the other earthy salts and of the pure earths. This theory certainly seems very simple and plausible; and it is so far countenanced by the known fact, that the plants most favourably acted on by gypsum are of very rapid growth, and might not be able, within the brief period of their growth, to find all the gypsum they require in ordinary ungypsed soils; and it appears to afford a ready explanation of the phenomenon, that gypsum is highly fertilizing to certain plants in some districts and utterly useless to the same plants, in seemingly the same circumstances, in others. Yet though it may, in some degree, be remotely or constructively true, it stops far short of explaining the action of gypsum in all cases, and possibly does not explain the direct action of it in any. Were gypsum a mere food of plants, it could operate much beyond the narrow limits which are known to circumscribe its action, and would maintain a steady place both among the fertilizers of soils and the proximate principles of certain plants; and, like any other saline substance which is indispensable to vegetable organization, it would be absorbable by any one crop only within definite limits, and would as surely kill by repletion when in excess, as enfeeble by inanition when in unduly small quantity. Some of the saline principles common to soils and to the plants which grow upon them, too, are remarkable for the dissolution, interchange, and recombination of their acids and bases, both in preparation for the spongioles and in elaboration within the plants; and gypsum so very probably ranks among these, or is one of the most prominent of them, that a doubt is admissible whether gypsum as a fertilizer be not decomposed within the soil, and whether gypsum as a proximate principle of some plants be not, like the alkaloids and the vegetable acids, formed by recombination of its elements within their own organism.

Liebig, accordingly, ascribes the fertilizing action of gypsum, at least "in some degree," to an exchange of principles between it and the carbonate of ammonia within the soil; and he ascertained the fact of the exchange by a simple and obvious experiment. "The evident influence of gypsum upon the growth of grasses," says he, "the striking fertility and luxuriance of a meadow upon which it is strewed, depend, in some degree, upon its fixing in the soil the ammonia of the atmosphere, which would otherwise be volatilized, with the water which evaporates. The carbonate of ammonia contained in rain-water is decomposed by gypsum, in precisely the same manner as in the manufacture of sal-ammoniac. Soluble sulphate of ammonia and carbonate of lime are formed; and this salt of ammonia, possessing no volatility, is consequently retained in the soil. All the gypsum gradually disappears, but its action upon the carbonate of ammonia continues as long as a trace of it exists. I made the following experiments on a small garden plot. Beans and pease were planted in the soil, after it had been well manured by mixing it with fresh horse dung. The whole surface of the plot was strewed with gypsum to the depth of a line, and then covered so as to be protected from the rain.—In dry weather it was duly watered. The plants soon appeared above ground and flourished with great luxuriance. Before the commencement of the experiment, I had examined both the soil and the gypsum, and found that both were quite free from the smallest trace of carbonates. But on testing some of the gypsum taken from the surface after the lapse of several weeks, I ascertained that the greatest part of it had been converted into carbonate of lime. All the soil to the depth of half a foot now effervesced strongly on the addition of acid." The fact, then, of the resolution of sulphate of lime and carbonate of ammonia in the soil into carbonate of lime and sulphate of ammonia, seems undoubtable; and this fact may be inferred to extend far beyond the mere ammonia of rain-water into the abundant ammonia evolved from the putrefaction of animal manures; and, when thus viewed, it would seem to point to a greatness and excursiveness of indirect fertilizing power in gypsum which seems never yet to have been realized or even suspected. One hundred pounds of burned gypsum converted within the soil into sulphate of ammonia, Liebig calculates, would be equal, in ammoniacal fertilizing energy, to what would result from 6,250 of horses' urine; so that, according to Boussingault's analysis of the composition of sainfoin, the usual dose of gypsum thus resolved ought to increase the eventual produce of the dry fodder of that plant far beyond what has ever been experienced. On the supposition, too, that gypsum fertilizes by exchanging principles with the carbonate of ammonia in rain-water, why does it not fertilize natural pastures, mangel-wurzel, and the cereal crops as much as sainfoin and clover? and, why does it not act as a perpetual and powerful natural fertilizer in such calcareous soils as naturally contain it in great abundance? and, on the seemingly fair inference, that it exchanges principles also with the carbonate of ammonia formed by the combination of pervading carbonic acid with the nascent ammonia arising from animal manures on or near the surface of the soil, why does it not operate as a mighty and universal enricher of all ordinary and recently-manured tillage-lands, for all sorts of cereal grasses and other alimentary plants? The only answers which undoubted facts will allow to be returned to these questions appear very distinctly to imply, that the exchange of principles between gypsum and carbonate of ammonia in the soil, must take place within narrow limits, and is far from being so unconditional as to afford any general explanation of the known phenomena of artificial gypsing. Were gypsum always capable of resolution with the ammoniacal contents of rain-water into sulphate of ammonia, it would act fertilizingly not only upon all kinds of ordinary tillage and grass lands, but even upon the hungriest sands and gravels, quite or very nearly destitute of organic matter; for sulphate of ammonia was proved, on a large scale in experiments by M. Schattenmann, to fertilize by its own proper force without the concurrence of any other manure, and, in consequence, to be serviceable to natural pasture and to impoverished and unkindly soils. According, also, to Liebig's own hypothetical statement—a statement which all farmers would be glad to find agreeing as well with facts as it does with his theory—"if we furnish to a field 40 lbs. of gypsum, and if we suppose that the tenth part of this enters into plants in the form of sulphate of ammonia, we would actually supply nitrogen sufficient for 100 lbs. of hay, 50 lbs. of wheat, or 60 lbs. of clover." But why, we again ask, is the fertilizing power of gypsum stubbornly refused, in the vast majority of experiments, to wheat, while it is just as generally given to clover; and why does it refuse to act upon any plants whatever without the concurrence of a considerable quantity of humus?

The fertilizing action of gypsum was supposed by M. De Candolle to be due to its stimulating the leaves of the plants on which it is sprinkled; and has been supposed by other writers, to be due to its stimulating either the absorbing vessels, or the interior organism, or the entire system of the plants. "The beneficial influence of gypsum and of many other salts," says Liebig, "has been compared to that of aromatics, which increase the activity of the human stomach and intestines, and give a tone to the whole system. But plants do not contain nerves; we know of no substance capable of exciting them to intoxication and madness, or of lulling them to sleep and repose. No substance can possibly cause their leaves to appropriate a greater quantity of carbon from the atmosphere, when the other constituents required for the growth of the seeds, roots, and leaves, are wanting. The favourable action of small quantities of aromatics upon man, when mixed with his food, is undeniable; but aromatics are given to plants without food to be digested, and still they flourish with greater luxuriance." Now though the theory of stimulation may go but very short way to account for the fertilizing power of gypsum, it scarcely deserves to be knocked down in this summary manner. Plants certainly have neither mind, nerves, nor proper organs of digestion, and therefore cannot either become drunk or go mad; but they possess organization, life, and sometimes great sensitiveness,—they are abundantly excitable by moisture, heat, and light,—they elaborate juices, effect chemical transmutations, and experience morbid derangements in ways strikingly analogous to even the highest order of animals,—and they therefore, cannot, without great violence of language, be denied a capacity of stimulation by chemico-physiological agencies. See the articles Excitability of Plants, Absorption in Plants, Analogy, Irritability, Cambium, Susceptibility, Sleep, Vascular Organs, and Spiral Vessels. How far, if at all, gypsum acts as a stimulant, we do not know; but it may quite possibly have a power of stimulating some peculiarity of organism or of vital action in the plants which it fertilizes, and may not have that power upon other plants in consequence of their wanting that peculiarity.

M. Chaptal advocates the theory of stimulation, but supposes the stimulation to consist in the saline impregnation of the sap taken into the plants from the water in the soil, and alleges the fertilizing superiority of gypsum over other saline stimulants to consist in its being very sparingly, slowly, and steadily soluble in water. "Few of the salts," says he, "contribute anything to the actual nourishment of plants. They are principally useful in stimulating their organs, and thereby increasing their power of digestion,"—it ought to be of assimilation or of elaboration and secretion, since the properly digestive part of the process takes place exteriorly to the plant, in the chemical transmutations within the soil. "Animals, by possessing the faculty of locomotion, have no difficulty in providing themselves with such saline stimulants, and with whatever else may be required to impart a healthy and vigorous action to their digestive organs; and having also the further advantage of will and instinct, they use these substances only in such proportions as their wants actually require. But plants, without any such power to help themselves, passively depend upon the air and water for all their necessary supplies; and this latter fluid carries to them indiscriminately whatever the earth contains that is capable of solution. It follows, therefore, from these premises, that the best saline manures are those which can only be very gradually dissolved. * * It is demonstrated that the salts most abundant in plants are those whose basis is lime or alkali. It is also proved by analysis, that these salts are present in variable proportions, in different species of plants, and even in different parts of the same plant. On the other hand, we may see it evinced by daily observation, that saline substances, to be beneficial to plants, must be applied only in moderate quantities. Thus, if too large a proportion of salts, easily soluble in water, be mixed with the soil, the plants which grow in it will inevitably suffer, and finally die; nor will they fail to languish if, on the other hand, they be altogether deprived of the stimulus afforded by salts. Since, then, the salts act upon plants, in proportion only as they are soluble in the water which is the vehicle of their conveyance, we may conclude that those which dissolve the least rapidly are the most beneficial to vegetation. The water, by being unable to dissolve the saline substances, except very gradually, can convey to the plants only a small quantity of them at any one time; and in this way, their effect will be constant and equable; nor will it cease so long as the soil contains any portion of salts. Their action, again, will be prolonged, in proportion as the soil is more abundantly charged with them; nor will the plants at any time be liable to receive more than they really require. Now gypsum appears to possess precisely the degree of solubility which is here shown to be desirable, 300 parts of water," Davy says 500 parts and Boussingault 460, "being capable of dissolving one part only of gypsum. Its action, then, must necessarily be constant and uniform, and without the possibility of its ever being so violent as to be hurtful. While the organs of plants, therefore, are gently stimulated by it, its effect is never to irritate or corrode them." Now this twofold theory of Chaptal—comprising a general one respecting all salts, and a particular one respecting gypsum—hastily assumes that gypsum can attract moisture during drought, as well as absorb it during rain,—that it does not undergo decomposition within the soil, but enters plants in its proper character of sulphate of lime,—and that all salts naturally or artificially occurring in the soil have the same mode of action upon plants, or produce only such effects as are referable to stimulation,—and it thus overlooks the important transmutations to which the proximate principles of gypsum may be subject under different conditions of soil, weather, and vegetation, and sets aside the vast differences between the action of salts which may be truly regarded as mere stimulants, and that of salts which, in even very small doses, are more or less poisonous, and that of salts which, when accidentally or occasionally absorbed, produce no appreciable effect and are afterwards totally excreted, and that of salts which constitute essential proximate principles, but not alimentary ones, of some plants, and that of salts which contribute part of their constitution, not only to the true nutrition of the plants themselves, but to those proximate principles of them which render them proper and nourishing food for animals. See the articles SALTS, ALKALIES, ABSORPTION IN PLANTS, PHOSPHATES, NITRATES, SULPHATES, SILICATES, AMMONIA, LIME, MANURES, ASHES, CHALK, and GUANO. Yet, in spite of such enormous defects, the theory—especially when viewed in connexion with the true doctrines respecting the action of saline manures—deserves attention; and after a better knowledge of gypsic action is obtained than at present exists, it may probably be found to explain some part of that action, and to suggest some new methods and circumstances in which gypsum may be successfully employed. Even Boussingault, who does not adopt either this theory or Davy's, says, "The hypothesis of Davy, supported by these ingenious views of M. Chaptal, would therefore lead us to regard gypsum as behaving to plants in the same general way as the insoluble salts which usually form an element of the soil or manures, the phosphate and carbonate of lime, in particular, salts which are made apt to enter the tissues of plants by the carbonic acid which is found in all the water that falls from the clouds, and that moistens the soil, and which has the property of dissolving small quantities of them. But whilst the strength of these solutions, weak at all times, is liable, through atmospherical vicissitudes, to vary, when the mere traces of saline matter which at best they offer at any time are inadequate to meet the demands of a crop disposed to grow rapidly and luxuriantly, such as clover, sainfoin, and lucern, the solution of sulphate of lime of the same strength at all times and under all circumstances, is ready to supply the plants with the mineral substance they require, however rapid and vigorous their growth."

Another view of the fertilizing action of gypsum assumes that the plants benefited by it contain a larger proportion of sulphur than other plants, and supposes that they obtain their supplies of it from the sulphuric acid of the gypsum. But though plants certainly decompose some substances presented to them within the soil, and most probably derive all the sulphur of their azotised proximate principles from gypsum and other sulphates, some of those which derive no benefit from gypsum, particularly the most highly nourishing of the cereal grasses and even of the glutinous rooted plants, appear to contain fully as much sulphur in azotised principles as the few which are benefited by gypsum. No doubt can exist, that in the case of wheat, oats, potatoes, and similar highly azotised and sulphuretted plants, all the sulphur required is abundantly supplied by the sulphates in ordinary manures; so that no room exists for a special supply of it from gypsum to sainfoin, clover, lucern, and rye-grass, except on the supposition of some special excitability or selectiveness or adaptation in these plants which does not exist in the others.

The only other view of the fertilizing action of gypsum which we shall name, ascribes it to the introduction of lime into the soil. "This," we are told, "is consistent both with the analysis of the ashes of the crops produced and the soil; for, according to the researches of M. Rigaud de L'Isle, gypsum operates only upon soils which do not contain a sufficient dose of lime in the state of carbonate." But if this theory be correct—and, when taken along with everything which it seems fairly to imply, it will probably be found nearer the truth than any other which has been advanced—it ascribes to gypsum the same variety or multiplicity of action which characterizes the behaviour of lime, and supposes gypsum to be greatly controlled or modified by the conditions of soil, cropping, and climate, and assumes that this salt is so decomposed within the soil as to exert the same powers which are elsewhere exerted by carbonate of lime, and affords full scope for the supposition that its sulphuric acid passes off into combination with ammonia, and that the sulphur of this acid eventually becomes fixed among the azotised products of vegetable assimilation.

We are thus conducted by our cursory review of the several theories which have been promulged, and especially of the last of them, to the conclusion, that gypsum as a fertilizer really behaves in a multiplicity of ways, and is much controlled or modified in its action by the special kinds or particular combinations of the accompanying agencies of meteorology, natural chemistry, and vegetable physiology. We have a strong opinion that hitherto both scientific and practical men have come far short of doing gypsum full justice as a manure; the former by looking at it only in some one supposed mode of action, and the latter by experimenting with it only or chiefly as a simple application, and not in combination with other substances or under a studied diversity of selected circumstances; and we should like well to see a comprehensive theory of it which should reduce all the plausibilities of all previous theories to a common harmony,—and still better, to see such a comprehensive theory inciting practical and experimenting men to try gypsum in numerous combinations and under a wide variety of circumstances, so as to ascertain whether, though effete by itself or in the ordinary methods of application, it may not be variously controlled and modified into powerful action. The abundance and the cheapness of the substance, and the facility with which it can be used, are strong inducements for making the trial. The same reasons which render the compounding of other mineral saline manures always desirable and sometimes necessary, may possibly be found to apply with peculiar force to the compounding of gypsum with, not one salt or two only, but with several. See the article MINERAL MANURES.—*Parkinson's Practical Observations on Gypsum as a Manure.—Boussingault's Rural Economy.—Chaptal's Chemistry Applied to Agriculture.—Davy's Agricultural Chemistry by Shier.—Johnston's Lectures on Agricultural Chemistry.—Johnston's Prize Essay on Gypsum and other Papers in the Journal of the R. Agricultural Society of England.—Liebig's Chemistry of Agriculture.—Q. Journal of Agriculture.—Buel's Farmer's Instructor.—Turner's Elements of Chemistry.—Anderson's Commercial Dictionary.*

GYROCARPUS. A genus of ornamental, tropical, ligneous plants, of the oleaster order. Two yellow-flowered, small, evergreen trees of it, the one from the East Indies and the other from the West, were introduced about 30 years ago to the hothouses of Britain. The name gyrocarpus alludes to the gyrating motion of the fruit.

GYROPHORA. A genus of lichens, of the idiothalami tribe. About 20 species have been scientifically described; and 8 or 9 of these inhabit the bare rocks of Britain. Two of the indigenous species, *G. deusta* and *G. pustulata*,—the former of an olive-brown colour, and scorched, rough, leafy appearance, and the latter of an ashy-green colour, and a pimpled and blistered appearance—are used, though not to any considerable extent, as dye-stuffs. The *G. deusta* flourishes throughout the year; but the *G. pustulata* is conspicuous only in spring. The name gyrophora may be translated "the bearer of a circle;" and alludes to the appearance of the disc of the thalli.

H

HABENARIA. A genus of curious and beautiful herbaceous plants, of the orchis order. The name is formed from a word signifying "a leather strap," and alludes to a spur ligulate protrusion of the flower. About 60 species are known; and nearly one-half have been introduced to Britain. Most of the introduced species are tuberous-rooted; about one-half are hardy; and the labellum of some is entire, while that of others is thrice or oftener divided. The fringed, the crested, and the fimbriated—the last with purple flowers, and many-divided labellum, and the other two with yellow flowers and entire labellum—are particularly elegant.

HABIT. The general appearance or aggregate character of a plant. It addresses itself either to the rapid glance of a botanist or to the careful attention of the general observer; and enables the latter as well as the former to assign to a plant a place in some class. Mere vegetable habit enables the most ignorant clowns to distinguish between mosses, ferns, grasses, herbs, shrubs, and trees; and the same index enables careful observers, who are totally ignorant of botany, to distinguish many entire natural orders, many entire genera, and even the varieties of some of the sportive or most cultivated species.

HABIT. An acquired and confirmed disposition in an animal. The habits of horses are of great consequence to their owners; and they mainly depend on the animal's early training and subsequent treatment. Their principal bad habits are restiveness, backing, biting, rearing, kicking, unsteadiness while being mounted, running away, taking the check of the bit into the mouth, troublesomeness while being groomed, mischievousness while being shod, crib-biting, wind-sucking, cutting with the shoe, reluctance to lie down in the stable, swallowing food unmasticated, the clicking of the hind foot against the shoe of the fore foot, shying, pawing, rolling, quidding, tripping, swinging the head and body from side to side, and slipping the head out of the collar.

HABIT. See INSTINCT.

HABRANTHUS. A genus of beautifully-flowering, tuberous-rooted plants, of the amaryllis order. It comprises many of the smaller kinds of amaryllideæ; and though not known in Britain till 1821, is now quite a pet genus among the higher class of florists. The name habranthus is formed from two words signifying "a delicate flower;" and, except for not alluding to the largeness and splendour of the flowers, is quite appropriate.

The changeable, *H. versicolor*, was introduced from South America in 1821; its stem is 9 inches high; its leaves are acute; and its flowers are white, tinged with pink, and tipped with red, and have a fragrant odour, and bloom in September.—The slender-leaved, *H. gracilifolius*, was also introduced from South America in 1821,—and, as well as the former species, is hardy; its stem is about 9 inches high; its leaves are cylindrical and very slender; and its flowers are pale-purple, with a green tube, and have a fragrant odour, and bloom in September.—The narrow, *H. angustus*, was introduced from Brazil in 1822; its stem is 6 inches high; its leaves are obtuse and narrow; and its flowers are purplish-red, and bloom in September.—The two-cleft, *H. bifidus*, was introduced from Buenos Ayres in 1823; its stem is 9 inches high; its leaves are narrow; and its flowers are pink or purplish-red, and lined with green below, and bloom in June.—Bagnold's, *H. Bagnoldianus*, was introduced from Chili in 1829; its stem is a foot high; its leaves are obtuse; and its flowers are yellow, spotted with pale red, and bloom in October and November.—Anderson's, *H. Andersonianus*, is a native of Buenos Ayres; its stem is a foot high; its leaves are acute and narrow; and its flowers are golden or copper-coloured, marked at the base with reddish-brown, and bloom in May.—The carmine, *H. kermesinus*, is a native of Brazil; its stem is a foot high; its leaves are linear, with an obtuse termination; and its flowers are funnel-shaped and nearly erect, and have a carmine colour, and bloom in June.—The other species introduced previous to 1845 are *H. phycelloides*, with a yellow and scarlet bloom in September; *H. intermedius*, with a red and greenish-yellow bloom in September; *H. roseus*, with a rose-coloured bloom in June; *H. robustus*, with a purplish-pink bloom, fading to white, in June; *H. pumilus*, with a rose-coloured bloom in June; *H. miniatus*, with a vermilion or light-red bloom in July; and *H. pallidus*, with a pale pink bloom in June.—All are propagated and cultivated in the same manner as the proper amaryllides.

HABROTHAMNUS. A recently introduced genus of ornamental, Mexican shrubs. The blue species, *H. cyaneus*, was introduced in 1844; and is a fine acquisition to the greenhouse, and may probably become a rich embellisher of our shrubberies. Its stem is about 4 or 6 feet high; its leaves are ovate-oblong and wavy, and have a downy appearance; and its flowers are produced in numerous clusters at the ends of the branches, and are tubular, half-pendent, and violet-blue, and bloom in August and September.—The purple species, *H. purpureus*, was also introduced in 1844; but is a soft-wooded and rather coarse-looking plant, about the size of a large pelargonium, with bunches of carmine flowers, similar in shape to those of the swollen tube-flowered heaths.—The bundled species, *H. fasciculatus*, is more ornamental than the purple species.

HACK. A pick-axe or mattock, with only one end, and that broad; also, a four-tined or five-tined hand implement for pulling out the roots of rushes, sedges, weeds, and other rubbishy aquatic plants from drains and ditches.

HACK, or HACKNEY. A riding horse let out for hire, a riding horse of inferior properties, or a road horse of any kind, whether good or bad, private or hired. A thoroughly good hack is more difficult to be had than even a good hunting horse.

HACKEN. A German plough. Its share has the outline of an isosceles triangle, or is a complete wedge with two equal sides, which always turn furrow-slices one over the other in the same direction; and the share, of course, cuts on both sides; and it has two strickles or strike-boards, which work alternately.

HACKLE. See HECKLE.

HACKNEY. See HACK.

HADDOCK,—scientifically *Gadus Æglefinus*. A common and well-known malacopterygian fish, of the cod family. It has a brown back, a black lateral line, a silvery belly, and a blackish spot behind the pectoral. It abounds in the seas of northern latitudes; and is as plentiful, but not so agreeable in taste, as the cod. It seldom exceeds 14 pounds in weight; but is always coarse when large; and does best for the table when only 2 or 3 pounds in weight. A haddock in a basin or sea-pond, communicating with the open sea at high water, exhibits remarkable docility, and is so acute in its perceptions as to be almost instantly tamed; so that, when artificially fed for a day or two, it knows its benefactor, swims toward him as soon as he appears, and follows him, almost like a dog, to the limits of its retreat.

HÆMANTHUS. See BLOODFLOWER.

HÆMATOXYLON. See LOGWOOD.

HÆMATURIA. See REDWATER.

HÆMODORUM. A genus of ornamental, greenhouse, herbaceous plants, constituting the type of the natural order Hæmodoraceæ. This order occurs chiefly at the Cape of Good Hope and in Australia. It is considerably allied to the iris order; and has equitant leaves, and anthers turned toward the ovarium. The roots of a number of its species afford a very lively crimson dye; and therefore give the name "blood-giver" or hæmodorum to the whole order. Nearly 30 species have been introduced to Britain; and these are distributed among 13 genera. Two of the introduced species, both orange-flowered evergreen herbs, blooming from July to November, belong to the genus hæmodorum.

HÆMORRHAGE. A morbid or accidental flow of blood from an animal. Hæmorrhages from deep or lacerated wounds, or from the cutting or rupture of moderate arteries, have far less morbid power in cattle and horses than in the human subject; and often are attended with no danger whatever in the former when they would be fatal in the latter; for, in consequence of the elasticity of the external tunic, the ends of the cut or ruptured vessels retract within the cellular substance, and close their orifices, and the flow of blood, though at first copious and alarming, soon becomes slow, and eventually forms a coagulum or clot, which plugs up the wound, and prevents all further flow. Yet hæmorrhage in cattle and horses may frequently be serious enough to make a great reduction of both condition and strength; and in every case, therefore, it ought, with all possible speed, to be artificially stopped.

Styptics, such as flour, puff-ball, alum, vitriol, and other finely pulverulent or powerfully astringent or corrosive substances, where applicable in the form of powder or in that of lotion, act either by mixing the blood into a thick paste or by astringing it into a coagulum, but have little or no effect upon a hæmorrhage of either ox, cow, or horse. Compression, by means of a dossil of lint, or a pledget of tow, or a piece of soft sponge, made fast with a bandage, is often effectual in any ordinary case of hæmorrhage, and is peculiarly suitable when the place of discharge is beyond the reach of more special manipulation; and even when the application but partially closes the bleeding orifice, it may occasion the speedy formation of a firm clot upon the whole. The passing of a ligature of waxed silk or thin twine round the bleeding vessel, is still more successful; and this may often be effected by means of a tenaculum or of any small hooked instrument, which can lay hold of the vessel, and draw it a little from its place; or it may be effected by seizing the ends of the vessel with a pair of small forceps; or, in the least practicable cases, it may be managed by taking up some of the flesh or cellular membrane in two or three places round the vessel with a crooked needle, having a waxed silk thread attached to it, and closing the included vessel by the constriction of the ligature upon the flesh. The tourniquet is seldom applicable to the horse; yet, in the form of twisted ligature, it may sometimes be advantageously used in cases of docking and of wounds in the legs. The cautery may be applied when a bleeding artery or vein is not broken or cut asunder; for it readily stops the hæmorrhage either by searing up the tubular cavity of the vessel, or by plugging up the orifice with a coagulum; but it ought to be applied at such a temperature, as merely to sear the part and not to destroy its vitality; for a part made dead by it will afterwards drop off, so as to reopen the orifice and renew the hæmorrhage. Yet, in the horse, the seemingly mischievous act of completely separating a partially divided artery, will stop the hæmorrhage; for the ends of the separated vessel retract within the cellular substance, and close up their orifices with coagulum; and hence the safety of tearing out the testicles in castration. But when a large vein is divided, it requires to be secured by one ligature above and by another below; and even when any very large artery is divided, both ends should, in prudence, if not in necessity, be secured with ligatures.

Hæmorrhage from the navel-string of calves is sometimes stubborn and dangerous. Blue vitriol, oil of vitriol, or some other powerfully corrosive styptic is frequently recommended, but ought never to be used; yet, when the ligature already in use is so near the belly as not to allow another to be passed above it, a styptic becomes necessary,—and one of the best is a pledget of lint, dipped in a decoction of galls, and made fast with a bandage, so as to combine the styptical action with a compressional one. But a simple ligature above the original one, whenever there is space for it, is decidedly preferable. Much swelling and inflammation generally follow; and these must be reduced by a sedulous and persevering course of fomentation, and eventually, if necessary, by poulticing and by the artificial discharge of morbid secretions. See the articles Wound and Bleeding.

HAGSNARE. The stump of a coppice-plant.

HA-HA. A sunk fence. A common form of it is a perpendicular wall on one side and a sloping ditch or trench on the other; but various forms, all comporting with neatness and regularity and strictly of the character of sunk fences, are practicable; and some forms of a medium-kind between the true ha-ha and the raised or ordinary fence, are also practised. A ha-ha is suitable only when no shelter is needed, and when an uniform surface of landscape, as in large gardens, extensive lawns, or any piece of park-scenery, is desired.

HAIL. A species of snow, or snowy rain, which has undergone several congelations and superficial meltings, in its passage through different zones of the atmosphere, some temperate and others frozen. It is generally formed in sudden alternations of the fine season. Hailstones are often of considerable dimensions, exceeding sometimes the length of an inch. They sometimes fall with a velocity of 70 feet a second, or about 50 miles an hour. Their great momentum, arising from this velocity, renders them very destructive, particularly in hot climates. They not only beat down the crops, and strip trees of their leaves, fruits and branches, but sometimes kill even large beasts and men. The phenomena attending the formation and fall of hail are not well understood. But it is certain that they are connected with electricity. This fact we find noticed by Moses, who relates that "the Lord sent thunder and hail, and the fire ran along upon the ground" (Gen. ix. 23). This has been supposed to account for the great variations of temperature to which the hail has evidently been subjected, in its passage through the different strata of the atmosphere. Artificial hail can be produced by an electrical apparatus, and volcanic eruptions are often followed by a fall of hailstones of great size. Hail-rods have been erected, at the suggestion of Volta, in countries much exposed to the ravages of hailstorms, on the same principle as lightning-rods. They consist of lofty poles, tipped with metallic points, and having metallic wires communicating with the earth. By thus subtracting the superabundant electricity from clouds, he imagined that the formation of hail might be prevented. These rods are used in Germany and Switzerland, but their success is not proportionate to the expectations entertained of them. The violence with which hail is discharged upon the earth, under an oblique angle, and independently of the wind, would be explained by Volta's supposition, that two electrical clouds are drawn towards each other in a vertical direction, and by their shock produce hail, which, by the law of the composition of forces, would be projected in the diagonal of its gravity, and of the result of the direction of the clouds. In Germany there are companies which insure against damage by hail.

HAIMS, or Hames. The collar-blades of a harness. See the article Harness.

HAINAULT SCYTHE. A reaping instrument of intermediate character between the sickle and the scythe. It is effectively employed in Flemish husbandry; and, when properly used, it cuts down, within any given space of time, from one-fourth to one-half more corn than the sickle. Its blade is broad and about 20 inches long; and its handle is about the same length as the blade, and is so fixed as to be at an acute angle with it in the act of cutting. When the blade lies flat on the ground, the workman has his hand nearly right over its curve, and can swing the instrument by a motion of his wrist without stooping; and he keeps his forefinger in the loop of a leathern strap attached to the handle, so as to prevent the instrument from gliding out of his grasp. He holds the hainault scythe in his right hand, and a bent hook with a handle three feet long in his left; he strikes with the scythe against the standing corn, and presses with the hook while cutting; and he deposits as much cut corn against the standing corn as will make half a sheaf, and then turns half round, hooks up the part of what is cut with an equal part of what is standing, and, with the aid of his foot and leg to keep all in its proper place, cuts and rolls up the whole in the form of a sheaf. The process makes clean work, leaves little stubble, and is very similar in its management to bagging; yet it seems, like the barn-sifting of corn, to require some peculiar and almost indescribable dexterity; for though often attempted to be introduced to Britain, and though tried to be taught to our reapers by Flemish workmen brought over for the purpose, it has hitherto failed to find its way into practice. Yet in spite of its manifest superiority over the very best sickle-reaping, many farmers of the most improved districts, are quite indifferent about it, and regard reaping with the cradle scythe as much preferable. See the articles BAGGING, REAPING, SICKLE, and SCYTHE.

HAINING OF GRASS. The preserving of a grass-field intact, for a time, from cattle, in order either to strengthen its vegetation, or to reserve the whole of its produce for use at an advanced season of the year. The term 'haining,' from this proper or technical employment of it, has gradually come, in colloquial language, to signify the reserving or temporary shutting-up of any kind of commodity, or such a calculating and parsimonious use of it as will keep it from being expended till a remote day.

HAIR. Hairs are filaments of a horny substance, more especially intended to cover the skin of the mammalia. One extremity of each hair is implanted in the cutis, and sometimes penetrates even as far as the muscular layer beneath. This extremity is enlarged into a bulb, more or less thick, sometimes containing a small drop of blood, the whole being enclosed in a membraneous sheath. When the hair is young this cell is large, and its size diminishes in proportion as the hair grows older. If punctured during its earlier stage, the blood flows, and it becomes soft and flaccid. That entire portion of the hair placed externally to the skin, is termed the shaft. It forms a very elongated cone, the free extremity being the apex. The hairs grow from their base, and hence are finer in young animals than in the old; for a similar reason, they appear to augment in number when cut, though in fact their extremities only are increased in diameter. When the nails rise out of the skin, they carry with them a small portion of the epidermis, which forms a kind of sheath around their base; this becomes gradually detached, under the appearance of transparent and whitish scales. Some animals have the hair in some parts of their bodies more or less developed at the time of their birth. In other parts no hair appears until a more advanced period of life.

Linnæus remarks that "Mammalia have hairs; birds have feathers; and fishes have scales." These assertions are true only in a general manner, for many mammalia either want hairs altogether, or are furnished with a very small number. This fact did not escape the observation of Linneus himself, who alludes to it in another part of his '*Systema Naturæ*.' Some species—such as those of the genus Manis—are in fact covered with true scales; and others—like the cetacea—have a naked skin. These exceptions are, however, more apparent than real in respect to the Manis, in which the scales are little less than compound hairs. According to M. Blainville, the last remark is equally applicable to the cetacea, where the hairs, becoming blended together, unite in forming a kind of crust or general envelope. This celebrated naturalist is even of opinion that the term *Pilifères*, or 'hair-bearers,' might form an advantageous substitute for that of *Mammifères*,—an observation with which we can by no means agree, as true hairs are also found on many birds, so that the term *Hair-bearers* would apply equally to them.

In general, the mammalia have two kinds of hair; the one bristly, more or less stiff, and external; and the other woolly, very fine, soft to the touch, and commonly hidden beneath the stronger hairs. The domestic species of sheep form a remarkable exception to this observation, on account of the abundance and length of the woolly hairs, and at the same time of the almost total disappearance of the coarse hairs. Animals of cold countries approach towards this peculiarity of the sheep. In warm regions, on the contrary, the bristly hairs are more strongly developed, and the woolly hairs become almost wholly wanting. The quantity, or rather the proportional abundance of the latter, is generally in the inverse ratio of the temperature, while that of the former is directly proportional to it, or nearly so.

The climate has a great influence on the nature of the hair, especially among the domestic animals. It becomes long and rigid in cold regions, as we remark in the Siberian dog and Iceland ram. Syria and Spain produce an opposite effect, and these more favoured climates produce a corresponding change in the hair, which may become tufted, fine, and silky. These qualities may be remarked in the Spanish sheep, the Maltese dogs, as well as in the goats, cats, and rabbits of Angora.

The coarser hairs bear a greater preponderance in certain parts of the body, especially among the males, such as in the cervical region of the lion and horse, where they form a mane, and on the tail of many species. Other animals are covered in every part of the body by very long hairs; such, in particular, is the bear of India (*Ursus labiatus*), in which the hairs are almost everywhere from seven to nine inches in length, and in some places even a foot long. In some species the fur is mixed, and in others it is sometimes composed entirely of spines, more or less abundant, and of various structure; such as the hedgehogs, the tenrecs, the genus Echimys, the porcupines, and many others. These spines or prickles are usually pointed, as their name indicates, and each is composed in general of a single hair. A great development of the muscles of the skin is always found in all species armed with spines, and this arrangement is especially remarkable in the hedgehog. It may also be observed, on comparing different species, that the spines are arranged in small and regular groups, the disposition of which is peculiar in each species.

It becomes difficult to examine the structure of the hairs on the human body, because they are slender; but the bristles of the hogs or the whiskers of the cats are better adapted for this kind of inquiry. On examining the bristle of a wild boar with the microscope, we observe that it is grooved throughout the whole of its length by about twenty furrows, formed by an equal number of filaments, and the union of which constitutes the surface of the hair. In the middle of the bristle there are two canals, which contain a humour called the pith or marrow. The filaments of the hair separate on being dried, as may be remarked in the bristles of brushes, where the cavities may be observed to be empty, and a few laminæ cross each other in different directions. The hairs of the elk and musk, with the spines of the hedgehog, the tenrec, and the porcupine, are not altogether similar; their surfaces being covered with a horny lamina, varying in thickness, and a few furrows only can be observed. Internally they contain a white spongy substance, which appears at first sight strongly to resemble the pith of the elder-tree.

The colour of the hair appears partly to depend upon that of the mucous tissue; for where animals have differently coloured spots upon the hair, these usually indicate corresponding colours below them in the skin. Even in the human species, many striking relations of this kind may be remarked. Thus, Negroes in general have the head black. Persons with red hair often have the skin freckled or covered with reddish spots, while black hair usually accompanies a dark complexion. The external colours of animals depending on those of their respective mucous tissues are exceedingly various. Among the mammalia, it is very seldom that they appear of a vivid hue. On some species of mandrills, the nose and hips are bright red, violet, and carmine. The mucous tissue is also pure white on their cheeks; and of a beautiful silvery whiteness on the bellies of the cetacea. In the mammalia generally, the mucous tissue imparts its hue to the hair and nails. It is often observed to be coloured within the cavities of organs, into which it has been prolonged, such as on the palate, the tongue, the ear, the conjunctive and nasal membranes of the quadrumana, dogs, ruminantia, and cetacea. The mucous tissue appears to be thickest in the class last-mentioned. On the backs of the dolphins and porpoises it is very thick, and of a deep black.

The colours of the mammalia have not that metallic lustre which characterizes a large number of the genera of birds, there being one solitary exception to this observation in the brilliant lustre of the Chrysochloris or Cape mole. We do not find among these animals the dazzling brightness of the parroquets, the tanagers, or the flamingoes, nor can we discover anything analogous to those ornamental appendages which adorn the plumage of many birds. There is another peculiarity in the colours of the mammalia, that they are in general much paler and fainter beneath than on the back or flanks. This may be observed not only in the true quadrupeds, but even in those species, such as the kangaroos, which more or less are in the continual habit of maintaining an upright position. Yet, without enumerating all those species which are entirely of one colour, such as the coaita, *Ateles paniscus*, the Polar bear, *Ursus maritimus*, we find some exceptions among the rodentia, and especially in the order of Carnassiers, such as the hamster, the gluttons, the badger, and some other species, while many even have the belly absolutely black. In particular, we may notice a carnassier recently described, for the first time, by M. Frederic Cuvier, who has assigned to it the specific name of Panda. The colours of the males among the mammalia are most commonly the same as those of the females, excepting perhaps that the shades of the latter are not quite so deep. In this respect they differ remarkably from the greater number of birds, in which the colours of the female differ almost wholly from those of the male. However, all the other circumstances which influence the colours of birds act equally upon those of the mammalia, although most commonly in a different manner. Age, for example, varies the colours of the fur only in a small number of species, as among the stags, the tapirs, and the lion, all of which are clothed at their birth in a kind of livery, or peculiar arrangement of colours. Their coats, instead of being uniform, as in the adults, are at first ornamented with spots, regularly disposed, and analogous in their arrangement to those observable in the adult animals of other species belonging to the same genus. Thus the spots of the young fawns are white, similar to those of the adult axis; while they are black in the lioness' cubs, in the same manner as we see in most adult cats. This very remarkable relation between the system of colouring belonging to the young individuals of one species, and that observed in other species of the same genus, may also be traced among the birds. But the young of the mammalia differ from those of birds in this respect, that—while the plumage of the latter, most commonly resembling that of their mothers, is duller in its hues than at a more advanced period of life—the livery of the young mammalia is, on the contrary, an ornament which they gradually lose as their years advance, until they finally resign the spotted and agreeable garb of youth for one of a more simple and uniform character. The colouring matter of the hairs resides in the horny part of their substance. and not in the pith, which is commonly white, We can observe this structure most conveniently in the spines of the porcupine, from their unusual magnitude. Some hairs are coloured differently in several parts of their length, while the colours themselves may be infinitely various, both in quality and intensity. In general, the hairs of the mammalia are round, and this form is observed more especially in the hair of the head or mane. On the tail of the hippopotamus, as well as on the body of the great ant-eater, and especially on the ornithorhynchus, they assume a flattened appearance; and in several species of the ruminantia, especially the musk, *Moschus moschiferus*, the hairs appear as if they had been crimped. In some varieties of goats, cats, and others, the hairs are fine, long, and silky; they appear both crisped and frizzled in the rams. From their great thickness, stiffness, and elevated position in the hogs, hedgehogs, and porcupines, they have received the name of *Spines* in the two last-mentioned animals, and of *Bristles* in the first.

All mammalia possess a certain quantity of hair, without excepting the cetacea, in general destitute of this covering. Man is covered in almost every part of the body by scattered hairs, although they are not easily perceived in some places from their excessive fineness. Those of the head and beard are the longest; those of the axilla and pubes are next in length. On the interior of the nose and ears they are shorter, and on the remaining parts of the body they appear of a still more diminutive length. Contrary to the arrangement in the other mammalia, the hair is longer on the breast and abdomen than on the back. There is never any hair on the palms of the hands or on the soles of the feet. Among the quadrumana, the true apes have the hair of the head in general of the same length as that of the body. The hairs which cover the fore-arm point upwards towards the elbow, instead of being directed towards the hand, as we may see in the orang-outang and some other species. The buttocks are callous in a great many quadrumana, and entirely deprived of hair. In most species of cheiroptera, a few scattered hairs only can be seen on the membranes of the wings, the nose, and the ears. One species of bat (*Vespertilio lasiurus, L.*) has also a few upon the tail. The remainder of the body is covered by short, fine, and villous hair, as may be seen in the flying-cats (*Galeopithecus*), and other animals of their order. The spines of the hedgehog are found only upon the head and back; the limbs and lower parts of the body are covered with stiff bristles. In these respects, the tenrecs resemble the common hedgehog. In some species the spines and bristles are mixed together indiscriminately. The hair is fine, short, and close in the moles and shrews, so that their skins seem as soft as velvet to the touch. Among the carnivora the hair varies considerably. There are two kinds of hair in the weasels, sables, ermines, martins, and others; the one being very fine, thickset, intermixed, and placed close to the skin; while the other, which is longer and stiffer, alone appears at the surface. These two kinds constitute the finer furs. The amphibious mammalia have short, rigid, and very close hair. The arrangement found in the carnivora may also be remarked among the finer haired rodentia. The spines of the porcupine are more slender, short and flexible on the head, neck, and belly, than on the back. There are about ten or twelve placed upon the tail, and resembling the tubes of quills, truncated at the free extremity. A rustling sound is emitted from these spines when the animal moves its skin. Among the edentata there is found a considerable diversity in the quality of the hair. It is broad and flat in the great ant-eater (*Myrmecophaga jubata*), and has a longitudinal furrow in both surfaces, so that each hair presents the appearance of a dried blade of grass. The two-toed ant-eaters are covered, on the contrary, with very fine wool. Several have hard and sharp-edged scales placed one over another, like the tiles of a house, as we see an example in the manis. Others are covered with prickles, like the spinous ant-eater (*Echidna*). The armadilloes (*Dasypus*) have, in addition to the scales or osseous bands, which cover the back and head in regular compartments, some scattered hairs, which are short and rigid like those of the elephant. These hairs drop off, however, as the animal advances in age. The hogs, of all pachydermata, have the greatest quantity of hairs, which in them are called bristles. These are scattered and frequently bifid at their free extremity. The other genera of this family are comparatively almost destitute of hair. It is in general short in the solipeda, excepting on the mane and tail, where it receives the name of horse-hair (*crines*). The bulls, deer, antelopes, and giraffe, have short hair in general. In the camels it is very fine and soft, and remarkably so in the lamas. All of them may have callosities, which are destitute of hair, on the knees and breast. Goats' hair is long and fine, extending to a pointed beard under the chin. The hair of sheep is long, and readily distinguished by that crisp and frizzled appearance, well known in the wool of commerce.

The hair of all these animals, when submitted to a chemical analysis, yields nearly the same results, whether it be examined under the form of wool, bristles, spines, or scales. On being subjected to the action of heat, in open vessels, it fuses or liquefies at first by swelling up. It subsequently emits a white flame, and resolves into a black carbon, the incineration of which is very difficult. Hair yields, on distillation, a reddish liquor, containing prussiate of ammonia, and another salt of an ammoniacal base, combined with a peculiar animal acid, which Berthollet has named zoonate of ammonia. The carbonaceous residue at the bottom of the still is light, and contains carbon and phosphate of lime. The hair does not dissolve completely in boiling water, —a mucilaginous matter, which is the pith or medulla, being separated from it. Caustic alkalies and some acids dissolve it entirely. Sulphur, silica, iron, and manganese, may be traced in the hair.—*Cuvier.*

HAIR-GRASS. See AIRA.

HAKEA. A genus of ornamental, evergreen, Australian shrubs, of the protea order. Two species of it were introduced to Britain in 1790; and about 50 species were introduced before 1837. All have an arid and exsiccated appearance, similar to that of the banksias and the dryandras; most have a fine outline, and elegantly bushy shape; nearly all are white-flowered; the greater number have a height of from 3 to 5 feet; and some have peculiarities of foliage, which are descriptively referred to in their respective names of furze-like, prickly-leaved, thistle-leaved, buckthorn-leaved, rusty-leaved, ruscus-leaved, petrophylla-like, hedgehog-formed, pectinated, needle-leaved, horn-leaved, olive-leaved, dactylus-like, three-forked, and woolly. They require the same treatment as the banksias; and most are propagated from cuttings.

HALESIA. See SNOWDROP-TREE.

HALIMODENDRON. See CARAGANA.

HALLERIA. A small genus of ornamental, evergreen, Cape-of-Good-Hope shrubs, of the figwort order. The shining-leaved species, *H. lucida*, was introduced to Britain about the middle of last century; and has been called by some gardeners the African fly honeysuckle. Its stem is branchy and about 6 or 8 feet high; its leaves are opposite, oval, and serrated; and its flowers grow scatteredly among the foliage, and lie hidden beneath it, and have a scarlet colour, and bloom from June till August.

HALLIA. A genus of small, evergreen, purple-flowered, Cape-of-Good-Hope plants, of the genista division of the composite order. Five or six species, chiefly herbaceous, and short-lived, and not of very interesting appearance, have been introduced to British botanical collections.

HALLOWE'EN. See ALL-HALLOWS.

HALLOWMASS. See ALL-HALLOWS.

HALO. An extensive luminous ring, including a circular area, in the centre of which the sun or moon appears; whose light, passing through an intervening cloud, gives rise to the phenomenon. Those about the moon are most common. When the sun or moon is seen through a thin cloud, a portion of the cloud round the sun or moon appears lighter than the rest, and this luminous disc is called a *corona*. Coronas are of various sizes, but they seldom exceed 10° in diameter; they are generally faintly coloured at their edges. Frequently, when a halo encircles the moon, a corona surrounds it.—*Parhelia*, or mock suns, vary considerably in general appearance: sometimes the sun is encircled by a large halo, in the circumference of which the mock suns usually appear, which have often small halos round them.

HALORAGIS. A genus of tender plants, constituting the type of the natural order halorageæ. This order is closely allied to the order onagrariæ, —that of the fuchsias and clarkias and epilobiums; but is distinguished by its naked and solitary ovula. Fewer than 20 species of it have been introduced to Britain; and these are distributed among 7 genera, and, for the most part, possess little interest. Two of the species are curious, evergreen, undershrubs, of the genus haloragis, from New Zealand.

HALTER. A loose rope-bridle, without bits or curbs, and used simply for leading a horse or for tieing him up. The plain or common halter is a very simple affair; but, when this can be slipped by a tricky horse, a halter is used with leather head-gear, two straps, and a second throat-band.

HALTERES. Two short filiform organs, terminating in knobs, and rising behind the base of each of the wings of a dipterous insect. They are commonly called poisers or balancers.

HALTICA. See FLEA-BEETLE.

HALYMENIA. See DULSE.

HAM (BACON). See BACON.

HAMAMELIS,—popularly *Witch Hazel* or *Dwarf Hazel.* A small genus of hardy, deciduous, ornamental, tall shrubs, constituting the type of the natural order hamamelideæ. This order is closely allied to the amentaceous group, and has been separated from it, more by artificial arrangement, than from any material difference in either habit or botanical characters. Only two genera and about 6 species of it are known in Britain; and all have been introduced from America.

The Virginian witch-hazel, *Hamamelis virginica*, was introduced in the former part of last century. Its stem has a height of from 4 to 12 feet; its branches are numerous and slender; its leaves are alternate and closely resemble those of the common hazel; and its flowers are yellow, and grow in clusters from the young shoots, and bloom from early summer till near the middle of winter, but have a poor appearance. This plant possesses no great beauty, yet serves to diversify a small wood or large shrubbery.—The long-leaved species was introduced about 35 years ago, and is taller than the preceding, but blooms at the same seasons.

HAMELLIA. A genus of ornamental, evergreen, tropical shrubs of the madder family. Six or seven species, chiefly yellow-flowered, and varying in natural height from 2 to 12 feet, have been introduced from the West Indies and the hottest parts of Continental America.

HAMES. See HARNESS.

HAMILTONIA. A deciduous, North American shrub, of the sandal-wood family. It constitutes a genus of itself, and is specifically called *oleifera* or the olive-bearing. Its stem is usually about

6 feet high; its flowers are greenish-yellow; and its fruit yield a fixed oil, and occasion the whole plant to be sometimes called the oil-nut.

HAMMEL. A small shed, and small attached court, for feeding one or at most two black cattle, A series of hammels forms part of the arrangement of every good farm-yard; and is found far more suitable than houses and large courts for winter-feeding. Hammels may be of various sizes, and variously arranged; but all ought to be constructed substantially, and with every facility for the classifying of cattle, and for the most economical methods of feeding, fattening, and littering. See the articles Feeding of Cattle, Farm-Buildings, and Farm-Yard Manure.

HAMMER. An implement for driving nails, —too well known to need description.

HAND. The unguiculated organ of touch. The hand is formed of two rows of bones called the carpus or wrist; of one row called *metacarpus;* and of fingers, each composed of two or three bones, called *phalanges.* The forms of the wrist and remote extremities vary with the delicacy of the organs of touch. It is only in few genera that a hand, properly so called, is found; but when it exists it is always much less complete, and therefore less useful than that of man. The mechanism of the human hand is exceedingly curious, and admirably adapted for the various purposes of life. Anaxagoras is said to have maintained that man owes all his wisdom and superiority over the other animals to the use of the hand; but Galen's view of the matter was rather more philosophical. According to him, man is not the wisest creature because he has hands; but he had hands given him because he was the wisest creature, for it was not hands that taught him the arts, but reason. The great superiority of the human hand over that of any other animal, arises from the circumstance that the thumb is of a great size and strength, and can be brought in opposition to the fingers. It thus gives man the power of holding whatever he seizes; and were it not for the thumb, various arts and manufactures of civilized life would either remain unexecuted, or would require the awkward concurrence of both hands. Albinus calls the thumb a second hand,—"*Manus parva majori adjutrix.*" The want of the thumb, and the absence of fingers of any great length, compel the squirrel, rat, and opossum, to hold objects in both paws. The cat and dog, which are obliged to use their fore-paws for progression, only hold objects by fixing them on the ground. The solipeda and ruminantia cannot hold objects at all. On comparing the hand of the apes with that of man, which it most resembles, we cannot fail to remark the smallness of their thumbs in proportion to the length of the fingers. These are slender and very long, while the thumb is weak, small, and short. In the cercopitheci, the thumb is concealed under the integuments, and their mode of seizing food and bringing it to the mouth differs but slightly from that employed by the squirrel. The fore-foot of the horse is terminated by a single bone, called the *coffin-bone*, corresponding in some degree to the third phalanx of the human finger, as the pastern, to which it is united, is analogous to the first phalanx. There are also two short and immoveable bones placed behind and on each side of the coffin-bone, called splint bones.

HAND. A lineal measure of height. It is the usual or average breadth of the fist or clenched hand; and is commonly reckoned at 4 inches. This measure is used in computing the height of horses; so that a horse of 5 feet in height is technically said to stand 15 hands high.

HAND-BARROW. See Barrow.

HAND-DRILL. A drill-sowing implement, driven or drawn by hand. A common variety of it is a one-wheeled barrow, with a hopper mounted upon it for containing and dropping the seed; and this is used for sowing turnip-seeds, pease, horse-beans, or any similar seeds upon small ridges; and may be driven along in the manner of a common wheel-barrow.—Another variety consists of a cross wooden bar, 21 inches long and 3 inches wide,—a long handle, attached to the middle of its front,—and four seed-droppers of wrought-iron plate, the two outer ones fixed upon the bar with their points distant from each other 18 inches, and the other two fastened on the bar by means of screws and nuts, so that both may be removed at pleasure, or the two may be adjusted equi-distantly from each other and from the extreme ones, or that the one may be laid aside and the other adjusted to the centre; and this implement is used for sowing onion-seeds, carrot-seeds, and other garden-seeds, and is suited to drills at the several distances of 18, 9, and 6 inches.—A third variety consists of a kind of one-wheeled barrow, with a long, projecting, transverse, and very simple apparatus for sowing clover-seeds and grass-seeds broadcast in the field; but this is very little used. See the article Sowing-Machines.

HAND-GLASS. A small glazed implement for aiding the propagation of plants from cuttings, for temporarily protecting small plants in the open ground, for sheltering transplanted small plants till they become established in the ground, and for other garden purposes in the open border requiring a similar combination of influences to that of the glazed hotbed or of the greenhouse. Hand-glasses are of very diversified size and form, and ought, in every considerable garden, to comprise a number of varieties. A convenient and very suitable ordinary kind may be 9 or 12 inches wide and correspondingly high, and may be formed either like four-sided prisms surmounted by four-sided pyramids, or like six-sided prisms surmounted by six-sided pyramids.

HAND-HOE. See Hoe and Hoeing.

HAND-LABOUR. The performing of physical

work, such as that of reclaiming waste-ground or of cultivating arable land, with the aid only of hand-implements, or without any assistance from machinery or from the domesticated animals.

HAND-PICKING. The hand-gathering of larvæ from plants, of weed-roots from fallow-lands, and of any other objects which require to be looked for and picked up one by one.

HAND-WEEDING. See WEEDING.

HAPALOSTEPHIUM. A genus of hardy, yellow-flowered, herbaceous plants, of the succory division of the composite order. It was constituted by David Don; and it comprises six species which formerly belonged to the hawkweeds, and two which formerly belonged to the hawk's-beards. All have an ornamental appearance, and bloom in July and August; and one, *H. paludosum*, formerly called *Hieracium paludosum*, a plant of about 20 inches in height, grows wild in the uplands of some parts of Britain. The name hapalostephium signifies "a soft crown," and alludes to the soft hairy receptacle of the florets.

HARD-GRASS. See ÆGILOPS, SCLEROCHLOA, and OPHIURUS.

HARDWICKIA. A genus of yellow-flowered, evergreen, tropical trees, of the cæsalpinia division of the leguminous order. Two species, each naturally about 40 or 50 feet high, were introduced some time ago to British botanical collections.

HARE. The generic characters of this well-known animal are, four cutting teeth in the upper jaw, and two in the lower; two of the upper teeth, however, are placed behind the others, and are of a much smaller size; the whole dental formula is, incisors $\frac{4}{2}$, canines $\frac{0}{0}$, molars $\frac{6}{5}$ $\frac{6}{5}$ = 28; the two four feet with five, and the hinder with four, toes. These animals are found in almost every part of the world, living entirely on vegetable food, and all remarkably timid. They run by a kind of leaping pace, and, in walking, use their hind feet as far as the heel. Their tails are either very short or almost wanting. The female goes with young about a month, generally producing three to six at a litter, and this about four times a-year. The eyes of the young are open at birth. The dam suckles them about 20 days, after which they leave her, and procure their own food. The European hare (*L. timidus*) is found throughout Europe, and some parts of Asia. The colour of this species is of a tawny red on the back and sides, and white on the belly. The ears, which are very long, are tipped with black; the eyes are very large and prominent. The length of this animal is about two feet, and, when full grown, it weighs six to eight pounds. It is a watchful, timid creature, always lean, and, from the form of its legs, runs swifter up hill than on level ground. Hares feed on vegetables, and are very fond of the bark of young trees; their favourite food, however, is parsley. Their flesh was forbidden to be eaten among the Jews and the ancient Britons, whilst the Romans, on the contrary, held it in great esteem. The flesh is now much prized for its peculiar flavour, though it is very black, dry, and devoid of fat. The voice of the hare is never heard but when it is seized or wounded. At such times, it utters a sharp, loud cry, not very unlike that of a child. It has a remarkable instinct in escaping from its enemies; and many instances of the surprising sagacity of these animals are on record, though it appears that all of them do not possess equal experience and cunning. A perpetual war is carried on against them by cats, wolves, and birds of prey; and even man makes use of every artifice to entrap these defenceless and timid creatures. They are easily tamed, but never attain such a degree of attachment as renders them domestic, always availing themselves of the first opportunity to escape. Among the devices of hares to elude their pursuers, the following have been observed: getting up into a hollow tree, or upon ruined walls; throwing themselves into a river, and floating down some distance; or swimming out into a lake, keeping only their nose above the surface; returning on their own scent, &c.

HAREBELL. Either the round-leaved bellflower, *Campanula rotundifolia*, or the undescribed squill, *Scilla non-scripta*. See the articles BELLFLOWER and SQUILL. The campanula hare-bell yields a dye-stuff.

HARE'S-EAR,—botanically *Bupleurum*. A genus of ornamental plants, with yellow, yellowish, and greenish-yellow flowers, of the umbelliferous order.

The round-leaved hare's-ear, *Bupleurum rotundifolium*, is an annual weed of the corn-fields of England, and is particularly abundant in the calcareous districts. Its root is small and tapering; its stem is erect, cylindrical, leafy, branched and somewhat corymbose above, and usually about two feet high; its leaves are alternate, broadly ovate, and frequently of a purplish hue; and its flowers are produced in terminal and compound umbels, and bloom in June and July. —The slenderest hare's-ear, *Bupleurum tenuissimum*, is an annual weed of muddy salt marshes on some parts of the English coast. Its root is zigzag; its stem is slender, wiry, smooth, erect, and usually about 6 or 8 inches high; its leaves are glaucous and narrow-lance-shaped; and its flowers are produced in solitary umbels, and bloom in July and August.—The odontitis or narrow-leaved hare's-ear, *Bupleurum odontitis*, is usually regarded as an importation from Italy, of about the middle of last century; but it occurs wild on the rocky parts of the coast of Devonshire. Its root is annual and tapering; its stem is wiry and about 9 or 10 inches high; its leaves are narrow-lance-shaped, and from one inch to two inches long; and its flowers have a reddishly-tinted cream colour, and bloom from June till August.—All these indigenous species are somewhat acrid, astringent, aromatic, and bitter. About a dozen annual species, and about a score of perennial-rooted species, all hardy, herbaceous, and more or less beautiful, have been introduced from foreign countries, principally in Continental Europe.

The shrubby hare's-ear, or Ethiopian hartwort, *Bupleurum fruticosum*, now most commonly called *Tenoria fruticosum*, is a beautiful, hardy, evergreen shrub, introduced from the south of Europe toward the close of the 16th century, and long ago a favourite member of many British shrubberies. The stem has usually a height of about 3 or 4 feet, but may easily be coaxed up to the height of 8 feet; the bark is usually brown on the old stem and reddish on the young shoots, but sometimes is greyish, and sometimes purplish-blue; the leaves are alternate, oblong-oval, entire, smooth, and fine pale green; and the flowers are produced in longish umbels from the ends of the branches, and bloom in July and August.—The arborescent hare's-ear, *Bupleurum arborescens* or *Tenoria arborescens*, is a similar evergreen shrub to the preceding, but only about one-third of the height, later in flowering, and far from being so hardy; and it was introduced about 35 years ago from the Cape of Good Hope.—Hare's-ear is also the popular name of an annual, white-flowered, cruciferous plant, of the cabbage genus or hedge-mustard genus, *Brassica austriaca* or *Erysimum austriacum*, which grows wild on the cliffs of some parts of England.

HARE'S-TAIL GRASS. See LAGURUS.

HARICOT. See KIDNEY BEAN.

HARIFF, or CLEAVERS,—botanically *Galium aparine*. An annual, indigenous, twining or climbing plant, of the madder family. It grows almost everywhere in hedges; and is well known for its ready adhesiveness to almost everything which it touches. Its root is fibrous; its stem is brittle, quadrangular, branched, and usually about 3 feet high, and supports itself twiningly and stragglingly upon other plants; the angles of the stem and the edges and keels of the leaves are profusely armed with minute hooked prickles, which make the plant stick to any animals, clothes, or hands which touch it; its flowers grow on lateral leafy stalks, and are few, small, and whitish, and bloom from May till August; and its fruit is a double spherical capsule, beset with the same kind of minute hooks which arm the stem and leaves. The juice of the plant possesses a doubtful celebrity as a remedy for scurvy and cancer; and the fruit has been proposed as a substitute for coffee. See the article BEDSTRAW.

HARNESS. The artificial means of fully connecting a draught-animal with his draught. Harnessing has been widely various in different ages and countries; it continues to be considerably various for any one specific object, in different regions and even in different districts at the present day; and it requires to comprise many and wide varieties, in adaptation to different animals, and especially to different purposes or different kinds of draught. But one or two common examples on the farm will sufficiently illustrate the whole subject of harness; and we select as the most suitable the harnessing of the plough-horse and the cart-horse in the mutually bordering districts of Scotland and England.

The collar of the plough-horse encircles the neck, supports the attachment of the draught, and presses against the shoulders. See the article COLLAR. The haims or hames are two bars of wood, so shaped as jointly to fit into a groove round the anterior part of the collar, and to lift their upper extremities above it; their lower parts are necessarily much curved, in order that they fit the curvature of the collar; their lower extremities are attached to each other by means of a small chain; their upper extremities are brought toward each other, and held tightly in their position by means of a leather strap and buckle; and the side of each is provided with an iron hook for the attachment of the draught. The trace-chains are the light chains of draught; and one end of each is linked into the hook of the haims, while the other is hooked into the eye of the plough's swing-trees. The leather back-band passes over the back, near the groins, and supports the trace-chains by means of hooks. The bridle commands the head and guides all the movements; and it consists of several parts, and may be constructed in various ways, either with or without blinders. See the article BRIDLE. The plough-reins, consisting of slender ropes, are attached to the bridle-rings, and pass through rings on the haims and the back-band, and along the stilts of the plough, to a looped termination at the hands of the ploughman; and for keeping the horses' heads sufficiently near each other, and within requisite mutual restraint, either a leather strap is buckled at the ends to the bridle-rings, or a short rope-rein extends from the bridle-rings to the anterior ends of the trace-chains.

The cart-horse, as well as the plough-horse, and quite or nearly in the same way, requires collar, haims, and bridle; but he does not need trace-chains, single back-band, plough-reins, or connecting leather-strap; and he requires a cart-saddle and girth, a breeching, two back-bands and girth, suspension-chains for sustaining the cart-shafts upon the saddle, a stretcher, and driving-reins. The total weight of the harness of each plough-horse needs not be more than about 36 or 38 lbs.; nor the total weight of the harness of a cart-horse more than about 52 or 54 lbs.

The harness of a draught animal, whatever be its parts or conformation, ought in every instance to fit exactly the animal, and to be always in good order. The collar and the saddle, in particular, ought to be thoroughly suitable in size and shape, and thoroughly adapted to the maintenance of a maximum of ease and comfort: for when they incommode the animal, or render him uncomfortable, or especially when they absolutely gall him, they make him restless and reluctant to work, and destroy his temper, waste his powers, and entail upon him useless and perhaps severe suffering. Even an improper adjusting of the haims or the girth, may greatly distress him, and waste much of both his strength and his temper. The methods of attaching the draught, also, and the direction which the line of draught is made to take with reference to the centre of gravity, are of the utmost consequence, and may happen, through ignorance or inconsideration, to be so exceedingly bad as to neutralize by far the greater portion of the animal's power, and make it hard enough work for him to drag along his own body. See the articles Draught, and Cart.

HARONGA. A genus of plants, of the bitter, astringent, febrifugal family of St. John's-wort. The Madagascar species, *H. madagascariensis*, is a yellow-flowered, evergreen shrub of 10 or 12 feet in natural height; and was introduced about 20 years ago to the botanical collections of Britain.

HARRIER. A subvariety of the hound division of the dog genus, kept specially for hunting the hare. It comprises three principal breeds, the old harrier, the modern harrier, and the beagle; it comprises also some subordinate breeds; and it has been used, likewise, for producing some cross-breeds. See the article Dog.

HARRIER,—scientifically *Circus*. A genus of raptorial birds, of the hawk and falcon division of the order accipitres. The marsh harrier, *Circus rufus*, frequents the low grounds and moorish heaths of Britain; and usually keeps within reach of morasses and water, in order to hunt reptiles. It is sometimes mistaken for a buzzard; and is often popularly called the harpy, the white-headed harpy, and the hawk-duck. Its total length is from 20 to 23 inches; its body is brownish and reddish; and its tail and the primary quills of its wings are ash-coloured. It roosts and nestles on the ground, and feeds on reptiles, rats, young rabbits, sea-birds, and whatever of a similar kind comes in its way.—The hen harrier, *Circus cyaneus* or *Circus albicans*, is also a native of Britain. It is called hen harrier from its supposed depredations in the farm-yard; and it popularly bears the names, also, of blue hawk and dove hawk. It has prevailingly an ashy-grey colour; but its wing-quills are black. It roosts on the ground, flies near the earth, keeps constantly in the fields, and toward night, hunts rats, partridges, and other prey.

HARROW. An implement of draught, for pulverizing soil which has been stirred by the plough, for disengaging from it the roots and lower stems of weeds, for thoroughly intermixing its component parts, and for covering the sown seeds of cultivated plants.

The History of the Harrow.—The harrow immediately succeeds the plough, both in the natural order of description, and in the uses to which it is applied. But—except that intermediate classes of implements, such as brake-harrows, revolving-harrows, scarifiers, and cultivators, more or less combining the action of the harrow with that of the plough, have, in modern times, been invented and multiplied—the harrow continues from remote times to be a very simple implement, while the plough has entirely relinquished its ancient forms, and has undergone thousands of transformations and improvements. The complicated ploughs of the moderns have no resemblance in form, and exceedingly little in action, to the rude machines with which the ancients scratched the soil, rather than tilled it,—and the best ploughs of the present day, in some districts or for some purposes, widely differ, in several of their prominent characters, from the best ploughs of other districts or for other purposes; but all the ordinary harrows of the moderns closely resemble the harrows depicted on ancient medals and sculptures, and may be regarded, not only as very simple, but as essentially imperfect.

The earliest or rudimental form of the harrow was probably a stiff, spinous, ligneous plant, of medium character between bush and tree, either a common hawthorn or any plant of similar size and habit, so cut, lopped, and pruned as to lie flatly on the ground, and make a great number of somewhat deep parallel scratches; and this rudest of all forms of it is still used in some of the cultivated parts of Asia. Another early form, also rudimental, though less so than the preceding, consisted of branches of stiffly ligneous trees, so dressed and fastened together that the stumps of their spray and branchlets acted on the soil in the manner of tines; and this form of it is still used in some parts of Russia. But a third early form—so early as to appear figured on ancient monuments, and to identify itself with very ancient practices of proper cultivation—consisted of a wooden frame of bars and crossbars, with projecting teeth; and though both the frame and the teeth of this were of wood, while the teeth of most modern harrows and both the teeth and the frame of others are of iron, it embodied nearly all the principles on which the harrow continues till the present hour to be constructed. Materials, weight, size, and mode of traction, indeed, have been greatly varied,—though more for adaptation to particular soils and purposes, than with the design of effecting any constructional improvement; but—with the exception of a change of form from the rectangular to the rhomboidal, and of modifications of several kinds upon the form and collocation of the tines,—changes designed to distribute the action of the implement more uniformly and steadily athwart the surface operated upon—and with the exception, also, of brake-harrows, revolving-harrows, and clod-reducing harrows, which, though retaining the name of the harrow, both possess the structure and perform the work of a higher and more complicated class of implements—the original, rude frame-harrow exemplifies all the same principles of power and mechanism which characterize the several varieties, light and heavy, wooden and iron, good and bad, of our modern harrows.

The Methods of Using the Harrow.—One driver or workman may employ either one horse and one harrow, or a pair of horses and a pair of harrows, or three horses and three harrows; but he makes thriftless work with only one harrow, and, except in rare instances or with harrows of very light construction or smaller than the usual size, he has much difficulty in commanding more than three harrows. Three men are required to drive three harrows when they are separate, while one man can drive them when they are yoked together; and three harrows yoked together can do as much work as four harrows in four separate yokes. "The reason," remarks Mr. George Robertson, "why two harrows are better in proportion than one, and three than two, is that a small piece of land, at the extreme diagonal corners of the space covered by the harrows, is insufficiently done, and must be overlapped the next time the harrows go round. This piece is to the same extent when one harrow is used single, as when two or three are yoked together. Thus, when one harrow is yoked by itself, it will not sufficiently harrow more than 2½ feet; but two harrows together will harrow 6 feet, and three will harrow 10 feet equally well. Each harrow, after the first, adds 4 feet to the space properly harrowed. Hence, three harrows in a set are better than four harrows separately, besides requiring one driver instead of four."

The workman in command of the team may either lead the horses, and walk before the harrows, or drive the horses by means of long whip-reins, and walk behind the harrows. But, in the former method, he cannot proceed as rapidly as in the latter; nor can he as easily, or with as little risk of a blow from the harrows, free them from occasional obstructions in the soil, and from successive chokings with weeds. He ought, by all means, to drive and walk behind; and he must ever be ready, either with his hand or with a crooked stick, to lift or jerk the harrows suddenly up so as to liberate them from obstructions and accumulations.

When the action of the harrows is required to no further an extent than a single turn or one double turn, they pass along the ridges; and when it is required to the extent of several double turns, they usually alternate a double turn along the ridges with a double turn across them, and make their concluding double turn along them. A single turn is effected, when the harrows proceed upon one belt of ground and return upon the adjacent belt; and a double turn is effected, when they both proceed and return upon one belt. A single turn is commonly sufficient at the sowing of the smaller seeds of grasses; one double turn or two double turns are commonly sufficient to give the finishing tilth to a piece of thoroughly summer-fallowed and completely pulverized soil; but several or even many double turns may be required for the reduction of ploughed grass land, for the earlier cleanings of coarse and foul summer fallows, and for other cases in which the ground is adhesive and matted with the roots and the decurrent fibres of either weeds or gramineous plants. See the article FALLOW.

To prevent the injurious effect of the treading of wet or finely pulverized soil by the horses' feet, attempts have been made so to construct and yoke harrows as to allow the horses to walk in the furrows. But though the attempts are practicable enough on narrow ridges, they have been found possible only with complicated and expensive machines on broad ridges. In any ordinary instance of a farmer being obliged, in an unfavourable season, to harrow the ground when it is in a very wet state, a beam may be so attached to a set of three, four, or more common heavy harrows as to extend quite across the ridge, and to allow the horses to be harnessed to the ends of it, and to walk in the furrows. But both on account of the greater efficiency of the harrows' action, and for the sake of preventing injury from the treading of the horses' feet, harrowing, except in cases of absolute necessity, ought always to be performed when the land is dry.

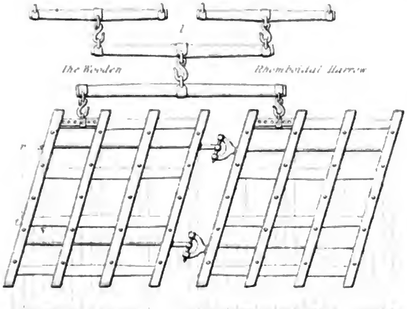
All the proper work of the harrows, as may readily be inferred from the lightness of the whole implements and from the comparatively slight hold which they take of the ground, makes but a very gentle and easy traction for the horses. Yet the irregularities of their motion, the starts and bounds which they make upon obstructions, and their alternations of skimming lightly when free from accumulations of weed and rubbish, and of lumbering heavly, when encumbered with these accumulations, sometimes occasion considerable labour; while the mere sinking of the horses' feet in the soft and pulverulent soil is frequently so laborious as to render the entire traction easier to a colt or a light pony than to an ordinary farm-horse.

The amount of harrowing which can be effected in any given time varies with the condition of the soil, the activity of the horses, the alertness of the workman, and the forms and combinations of the harrows; and it is somewhat variously estimated by leading agricultural writers of Britain and the Continent. Sir John Sinclair says, "In Norfolk, it is the custom to walk the horses against the rise, if any, and to trot them back again in the same place; the quantity done in this way is about 7 acres per day. In Scotland, a man and a pair of horses will do a single tine, as it is called, to the extent of 10 acres; but if a double tine, only 5 acres per day." Veit estimates, for one horse, an average of about 3⅓ acres per day; and he elsewhere says that a man, with the usual harrow, may go over from 4½ to 5 acres per day. Thaer says, "The difference is greater in harrowing than in ploughing. This arises from the degree of carelessness, and the character of the implement, with which the work is done. The round harrowing is the most difficult; and 7 yokes," nearly 10 acres, "of this is the highest which a four-span harrow can perform; but on bending and grassy soils, one must content oneself with 6 yokes. In even harrowing, without the breaking up of clods, 9 yokes," 12·8 acres, "may be accomplished; and in merely drawing along once, with one man and four horses, from 11 to 12½ yokes," from 15·6 to 17·8 acres, "may be harrowed." And Burger says, "When the harrow goes only once in the same line, in a soil not filled with weeds or very much bound together, so many as 4½ yokes," 6·39 acres, "may be harrowed in 9 hours."

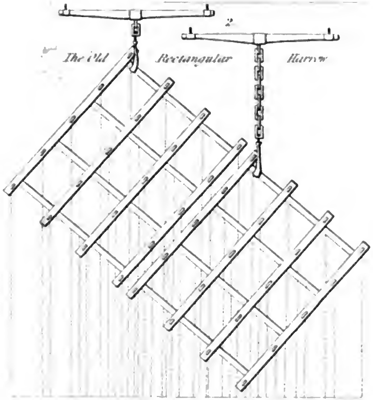
The General Structure of the Harrow.—As the harrow performs its work by means of teeth or tines, pressed into the soil merely by their own weight and that of the frame in which they are fixed, two prime considerations are the proper form of the teeth and the proper distribution of them in the frame. Were the harrow intended solely to drag up weeds and roots from the ground, the best form perhaps that could be given to the teeth would be that of a thin wedge, tapering to the point like the coulter of a plough, and, like it, inclining forward. But, although this form might be the best calculated for penetrating into the ground, and tearing up the roots beneath the surface, it would not be so well calculated for covering the cultivated seeds, as one which should present a broader surface to the earth, and so give a greater movement to the particles of the soil. The wedge for this latter purpose, as well as for pulverizing the clods of earth upon the surface, should not be thin but broad. In order, therefore, to adapt the teeth to these different purposes, to the strength necessary to be given to them, to the attrition to which they are subject, and to the lateral or shaking motion of the implement when encountered by obstacles, the best form is one whose horizontal section *h i k l*, *Fig.* 1, *Plate XXVI.* is a square, the diagonal of which is moved forward in the line of the harrow's motion. The teeth, however, must gradually taper to a point, the fore-part being kept straight; and they are generally inserted into the frame work with 'a rake,' as it is technically termed, or with slight inclination forward, so as the better to insinuate themselves beneath the roots which they are to raise to the surface, and to have a tendency downwards rather than upwards, when encountered by obstacles beneath the surface. As to the distribution of the teeth in the frame of the harrow, they should not be too closely set, for then they would be constantly impeded by the obstacles opposed to them; and, they ought, also, to be so disposed in relation to one another as to give all parts of the implement an equal degree of liability to obstruction. The number of teeth, moreover, should not be too great, because then their power to penetrate into the ground would be diminished, unless the weight of the whole implement were increased in a corresponding degree; and, lastly, their length should not be greater than is necessary, because they would not, on that account, penetrate more deeply into the ground, unless the whole weight were also increased,—and they would at the same time have a greater power, when encountered by obstácles, to split the frame in which they were fixed.

The harrows represented in *Fig.* 1, *Plate XXVI.*, are formed with a regard to these general principles. They consist each of four bars of wood, A, B, C, D, &c., technically termed bulls, and connected together by an equal number of cross bars of smaller dimensions, mortised through them. The former of these bars may be 2½ inches in width by 3 in depth, and the latter 2 in width by 1 in depth. The longer bars are inclined at a certain angle to the smaller, so as to form the figure of a rhomboid; and they have inserted into them the teeth at equal distances from one another. This inclination of the larger bars is made to be such, that perpendiculars from each of the teeth falling upon the line I K, drawn at right angles to the line of the harrow's motion, shall divide the space between each bar into equal parts; so that the various teeth, when the implement is moved forward, shall equally indent the surface of the ground over which they pass. The advantages of this distribution of the teeth and position of the bars, will best appear by comparing the harrows in *Fig.* 1 with those in *Fig.* 2. In the latter, which represent the old and unimproved harrows of Scotland, the bulls are not inclined, but are placed at right angles to the cross bars; and, in order to diversify the tracks of the teeth, each harrow is drawn by its corner. But here the teeth, though at equal distances from one another, in their several bulls, do not equally indent the surface, as will appear by drawing lines from their different centres, parallel to the line of the harrow's motion. This defect, indeed, could be obviated by attaching the line of draught more to the right hand; but then one of the corners of the harrow would still move before the other, which is an inconvenient position, and attended in practice with certain disadvantages.

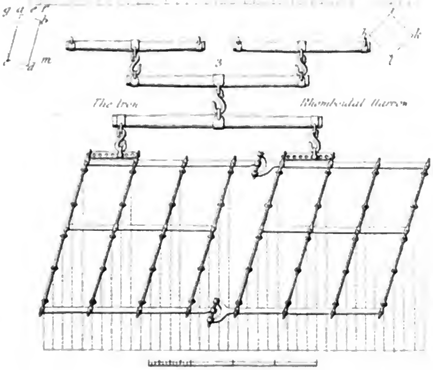
The number of teeth in the harrow is twenty, five being inserted in each bull. When two harrows, therefore, are employed together, the surface of the ground from I to K is indented by forty teeth, moving at equal distances from one another. The teeth may so project below the



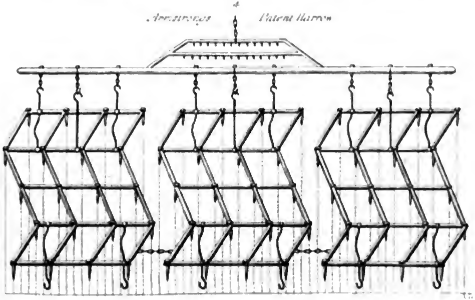
The Wooden Rhomboidal Harrow



The Old Rectangular Harrow



The Iron Rhomboidal Harrow



Armstrong's Patent Harrow

under surface of the wood, that the length shall be about six inches in the hindmost row, and shall gradually increase to about seven in the foremost, where the oblique position of the line of draught tends most to elevate the harrow. The teeth, it has been said, are generally inserted into the frame, with a little inclination forward. This deviation from the perpendicular, however, if made at all, should be very slight, because it renders the harrow more apt to be impeded by the weeds and rubbish raised by the teeth, and collected in the angle formed between them and the wood. The teeth are fixed in the bulls, by boring holes with an auger of about three-fourths of an inch diameter, and then driving the teeth firmly through. The best of the common kinds of wood for the bulls, on account of its being the least liable to split, is elm, birch, or ash, and for the cross-bars, ash; yet the whole may be made of well-seasoned larch. The teeth, when thus driven into the bulls, will be retained with sufficient firmness; though, in the very large and heavy species of harrow called brake-harrow, they should be further secured by means of bolts or screw-nuts.

The harrows referred to in *Fig.* 1, are connected together by the iron hinges L, M, N, O, which keep them at the distance required, and admit either of rising or falling according to the inequality of the surface. The method of attaching the animals of draught, will be explained by the apparatus represented in the figure, by means of which, each animal must exert an equal force in pulling. Here RQ, RQ, are the foremost slots of the harrows, bars of iron passing through the upper end of the bulls of each harrow. These bars have, on each side of the bulls AB, EF, a few holes or notches, so situated that the line of draught may be shifted to the right or left as may be required; and the staple P being the point to which the moving power of the whole machine is applied, it is important to ascertain its proper position. In order to place an equal number of the teeth on each side on the line of traction, it is apparent that the point P should be placed in the middle of the entire breadth covered by the harrows. This, however, would not be the true position of this point, unless each of the teeth were so formed as to be equally resisted by the earth on each of its sides. Thus, if a tooth, whose horizontal section is *a b c d*, were so moved forward that, in the rectangle *c g*, *f m*, *g e*, perpendicular to the line of traction, should be greater than *e f*, then the impinging earth would act with a greater force upon the left than upon the right side of the tooth, and so tend to turn the whole harrow round the point to which the moving power was applied. The point P, therefore, could not now be precisely in the middle of the breadth covered by the harrows, but would need to be applied so much more to the left hand as that the tendency of the implements to turn round should be counteracted by throwing more of the space covered by them to the right hand side of the line of traction. The effect, however, produced by any particular form of the teeth will generally be slight, owing to the limited surface which they present. But in practice there is found to be a considerable tendency in this species of harrow to turn round from left to right, arising from the oblique position of the bulls. When any obstacle raised above the surface of the ground strikes a bull, as at *t*, the force *t s*, which it exerts upon the motion of the harrow, may, according to the laws of mechanics, be resolved into the two equivalent forces *r t* and *r s* of the parallelogram *r s t v*, of which, the side *r t* in the line of motion will represent the force of the obstacle in resisting the advance of the harrow, and *r s* perpendicular to *r t*, the force operating to turn it to the right. Now, as there are not fewer than eight bulls in the harrows, and these of considerable length, it is evident that, in ground with any great unevenness of surface, there will be a constant succession of strokes, forming a strong lateral pressure on the left side of the several bulls, tending to push them to the right hand side. But the staple P, being nearly fixed in its position, while the hind part of the harrow may be moved round, the effect of this pressure is to turn the whole harrow upon P as on a pivot; and this effect on very rough ground will be found so considerable as often to place the bulls of the harrow parallel to the line of motion, thus causing all the teeth in the same bull to follow in the same track. Hence, then, P is not a fixed point, but varies with the nature of the surface; and hence means must be afforded to the driver of shifting the point at which the draught is applied to the right or to the left as may be required; and these means exist in the cross-bars RQ, RQ, which pass through the upper end of the bulls of each harrow.

The Varieties of the Harrow.—The old quadrangular harrow is represented in *Fig.* 2, *Plate XXVI.*, and has been almost sufficiently noticed, though but incidentally, in the preceding section. Its bulls, in general, are about 4½ feet long, 3 inches broad, and from 3 to 3½ inches deep; its slots, in general, are 3 inches broad and an inch or seven-eighths of an inch deep; and its teeth or tines consist of malleable iron, and are 20 in total number, or 5 in each bull, and each is about 10 inches in length, and projects from 6 to 7 inches beneath the under surface of the bulls. This variety of the harrow is greatly inferior to the rhomboidal variety; yet whenever it is still preferred, it may now, according to recent improvements, be made wholly of iron.

The rhomboidal harrow is represented in *Fig.* 1, *Plate XXVI.*, and has been very fully described in the preceding section. The rhomboidal form of it is the chief instance of the only essential improvement which has been made in the principles of the harrow since the times of the ancients;

and this was invented, about 55 years ago, by Mr. Low of Gordonbank, in Berwickshire, the father of the well-known professor of agriculture in the university of Edinburgh; yet, in spite of its great and manifest excellence, it came but slowly into use, and was not generally imitated in the construction of harrows, even in the south-east of Scotland, till about the third decad of the present century.—The hinges of the common forms of two mutually connected rhomboidal harrows, are adjusted together in close and well-fitted joints, and have their tails prolonged in a bolt through only the first and the second bulls; but the hinges in the newest and most improved forms of these harrows, as represented in the figure in our plate, have a wide-eyed single joint in the one harrow, and an arched double joint of about six inches of span in the other, so as to produce looseness and freedom of action, and have their tails prolonged in bolts through all the bulls, quite to the opposite sides of the harrows, so as to contribute to the increase of both the strength and the efficiency of the implements.

Since the recent extensive introduction of iron into the manufacture of large and heavy implements, rhomboidal harrows have very generally begun to be wholly constructed of that material; and in this case, they have fewer slots and far more slender bulls,—and, besides being more durable, and less liable to accidental injury, they expose a smaller surface to the resistance of obstacles on the ground, and perform somewhat more work in proportion to their weight. These harrows are represented in *Fig.* 3, *Plate XXVI.* The slots are only 3 in number, and may be 2 inches broad, but need not be more than ⅜ of an inch deep; the hinge-joints are formed upon elongations of the two end slots; and the bulls may be ½ an inch broad and 1 inch deep, and require to be swelled out at the mortises for the slots and for the tines.

Several or even many varieties of rhomboidal harrows, with either wooden or iron slots and bulls, are readily obtainable from manufacturers of agricultural implements, and may all be alike efficient for different purposes or on different kinds of land. One cheap and small variety, with wooden slots and bulls, is made for garden culture, with tines let in with shoulder and plate, and fixed angularly with nut and screw, and so arranged as to cut tracks in parallel lines at distances of 2½ inches; and a 14 lb. weight is fitted to be used when a deep tilth is required.

Armstrong's patent four-beam iron harrows exhibit a much wider deviation, than the rhomboidal harrows do, from the form of the old quadrangular harrows; yet they seem not at all likely to come into such general use as the rhomboidal harrows, and may be ranked as a less approved, though much more curious, instance of the one great feature of modern improvement on the principles of the ancient harrows. Three of these harrows, linked together into one gang, and adjusted to a single line of traction, are represented in *Fig.* 4, *Plate XXVI.* "These harrows," says the account of them in the Annual Register of Agricultural Implements for 1844, "are made in a peculiar zigzag form, by which means the tines are so arranged that they can cut a separate track from each other 2 inches asunder. They are made without the projecting corners, as in the old sort, allowing them to fall into the hollow parts of the land much better. One decided advantage they possess is in the principle of draught, which is from a centre. Upon the original mode of draught, the horses draw from each end of the whipple-tree, so that if one horse draws more forward than the other, the harrows are drawn out of their proper track, the tines being thus made to follow each other, thereby causing a total loss of horse-power,"—a remark, however, which, as may be seen from the statements in the preceding section, applies very slightly, and sometimes not at all, to the properly mounted and attentively driven rhomboidal harrows; "but upon the new principle of draught, let the horses draw ever so irregularly, one part of the harrows is not more affected than the other. The harrows are attached to the whipple-tree by double hooks, which prevent them, in rough work and in turning, from riding on each other. The teeth are made with a square shoulder, and secured to the frame by means of a nut and screws; consequently they may be taken out and relaid, without the frames or beams sustaining any injury. There are four bows or slides on the top of each harrow, placed there for the purpose of removing them from one field to another." These harrows, both in the variety represented in our figure, and in other varieties of different adaptations and prices, are made by Mr. John Howard of Bedford. One of the other varieties is in all respects the same as that represented, except that it is lighter in construction, and suited to sandy lands and all other kinds of light soils; another has an additional row of tines and makes tracks at distances of 1¾ inch; another has two additional rows of tines; and another is very light, and has a great number of tines, and is adapted for covering in small seeds, for following the drill, and for drawing over crops in the spring, to destroy young weeds, without injury to the cultivated plants. One set of Mr. Howard's patent iron harrows are made with two beams to each, and six harrows to the set, suitable for convex or high-backed lands, adapting themselves, by means of an extra number of joints, much better to the form of the land than when made wider, with four or more beams, and having the whipple-tree so made that the horses walk up the furrows; and another set—which he calls patent drag harrows—are made on the same principle as those represented in our figure, but much stronger, and made to draw backward or forward, so as to act in the former way like a grubber, and in the latter like a pulverizer or clod-breaker. Attempts, in short, are made to accommodate varieties of Armstrong's zigzag harrows to the purposes severally of the common cleaning harrows, the light seed-covering harrows, the brake-harrows, and, in some degree, the grubber and the clod-bruiser.

A registered expanding harrow, formed entirely of iron, was recently invented by Mr. Exall, and made by Messrs. Barrett & Co. of Reading, and was expected freely to adapt itself to the unevenness of the land, to admit of being put to any width from 4 to 8 feet, to be very easily and readily cleaned, and to combine the advantages of cheapness, portability, and durability; but it has not been found to answer expectation.—Expanding lever-harrows were invented and patented by Richard Colman of Colchester, Sussex; and were exhibited, of two sizes, at the Highland Society's Agricultural Show at Dumfries, in 1845, and are noticed as follows in the official Report of that Show: "These harrows embody two essential points—1st, The principle of their expansion, which is based on a strictly geometrical principle,—that a parallelogram, divided into any number of lesser parallelograms, by lines drawn parallel to two of its contiguous sides, will have these smaller, each exactly similar to the original figure; and whatever degree of obliquity may be given to the greater, each of the lesser will undergo the same change, preserving the exact similarity of figure. 2d, The harrows being supported on small wheels attached to levers, whereby any degree in depth of penetration by the tines is readily obtained at pleasure, by changing the position of the levers. The first property is an important one as applied to the harrow; and the changeable nature of the parallelogram when not tied by a diagonal, as well as the constant similarity of its integral divisions, are very beautifully brought to bear in this improvement. By their means, this harrow is capable, not only of making every tine form a distinct line in the soil, like the best kinds of common harrow, but the distance between the whole of these lines can be varied with mathematical exactness, both as to equality one with another and to extent of variation. Thus, they will draw lines that shall be all four inches, or all one inch apart, or at any fractional part of the distance between these; and the construction being effected, the changes are produced by simply changing the place of a hook in a chain. We have few examples in agricultural machinery where a geometrical principle has been so happily applied, and applied, too, to one of the rudest of implements. The variation in depth of penetration seems also a considerable step in the perfecting of this harrow, that being a point in which all others are defective. An objection was made to the use of cast-iron in these harrows; but the inventor stated that he also makes them entirely of malleable iron. As there was no opportunity of testing these harrows in the field, it would be premature to pronounce upon their *practical* efficiency, though in principle they are in advance of all others."

The rectangular drill harrows are employed chiefly in the culture of the potato; and are drawn along the drills by one horse, and applied in the early periods of the growth of the crop. Their object is to remove weeds and loosen the soil; but they are often marred in their efficiency by having too many teeth. No two of their teeth should stand nearer to each other than 6 inches; and all ought to be so arranged as to produce streaks at regular distances of from 2 to 3 inches.—The triangular drill harrows are used for the same purpose, and produce the same effects, as the preceding, and differ from them principally in form, and in the facility which their inclined bars afford for keeping the teeth well separated, and for producing streaks at every three inches with the least possible number.

Grass-seed harrows of various constructions are used for covering grass-seeds and clover-seeds, and sometimes for giving finishing turns to the covering of grain-seeds and the polish of the tilth; but they are often superseded by the common pulverizing harrows; and most of them, even as expressly made for covering grass-seeds and giving a finish to tilth, differ from ordinary harrows only in being lighter and smaller, and in having a proportionally larger number of teeth. Some varieties of grass-seed harrows, when intended for sandy lands or other very light lands, are made, also, with very small teeth of not more than 4 inches in length; and some are made with wooden teeth.—The bush-harrow is used sometimes as a substitute for the grass-seed harrows, but more commonly for cautiously cleaning the surface of grass lands, and for harrowing in top-dressings upon grass. See the article Bush-Harrow.—The iron-web harrow is a recent, elegant, and very efficient invention of Mr. Smith of Deanston, for achieving the same purposes as the bush-harrow. It mainly consists of annular, cast-iron discs, precisely similar to cast-iron playing-quoits, woven with iron wire of about one-fourth of an inch in diameter into a flexible web of about one foot in breadth and 6 feet in length; and this web is simply dragged along the surface of the ground, and possesses so free a texture as to keep the discs in constant play and motion.—A set of four very light seed-harrows, figured and described in Mr. J. Allen Ransome's Work on the Implements of Agriculture, is stated to have been invented by a friend of that gentleman, after his observing the efficient manner in which the seed-corn, in some parts of Norfolk, is covered by a common wooden-toothed rake. The frames are parallelogramic, and made of ash, and as light as possible;

the teeth of each harrow amount to twenty, and are made of iron, and project only 3 inches below the frame; and the four harrows have jointly a sufficient breadth to cover a ridge of 108 inches, and are hinged together lengthwise, and are attached by the middle of their respective fore-ends to a single bar, which extends quite across the ridge, and has its draught-attachments at the ends, so as to require the horses to walk in the furrows. But one serious disadvantage of this implement is, that, whenever the one horse walks in even a slight degree a-head of the other, all the harrows are so far thrown into the diagonal as to make the teeth of the second, third, and fourth bulls pass through the same tracks as those of the first, and leave three-fourths of the aggregate breadth of the ridge unharrowed.

The brake-harrow or break-harrow—or as it is sometimes abbreviatedly called, the brake or break—is simply a large and heavy variety, or rather class of varieties, of the common pulverizing harrow. It is designed to reduce and pulverize any kind of rough and stubborn land, and particularly any strong clay land, when in too obdurate a condition to be subject to the teeth of the common harrow; and it is made of either a rectangular, a rhomboidal, or a triangular shape, and in a considerable number of different ways. One somewhat common, though rather old-fashioned kind of it, is quadrangular, and has 6 slots, 5 bulls, and 25 tines, with the perforated bar of traction adjusted between the ends of the second and the third bulls; and another kind of it, which some authorities allege to exert a superior action, is rhomboidal, and has 4 slots, 3 bulls, and 15 tines, with the perforated bar of traction between the first and the second bulls, and worked in a set of two, so loosely though firmly hinged to each other as easily to suit themselves to the curvatures of the ridges. But brake-harrows of all shapes and forms are alleged by some good judges to be all alike efficient, provided they be heavy enough, and have tines of sufficient length and number, and properly arranged. Brake-harrows of all sorts, however, have become, in a main degree, antiquated,—partly from the subduing and pulverizing effects of drainage upon clay lands, and partly from the extensive introduction of scarifiers, grubbers, and other implements of facile and thorough fallow-cleaning. A whole class of implements, with the true grubbers as their type, now combine the action of the common harrow with that of the plough, so as very efficiently to perform the work which was formerly appropriated to the brake-harrow; and another though much smaller and quite recent class of implements, called revolving harrows, combine in some degree the action of the break-harrow with that of the scarifiers or the grubbers. See the article Grubber. An implement, called a crosscutting harrow, operating by means of three blades or coulters cutting across the plough furrow, and designed to improve and reduce moss-land, was invented in 1829 by Mr. Brown of Carabus in Islay. See the article Crosscutting.

A harrow of an entirely novel construction, and of great promise in the estimation of the judges, was exhibited at the Shrewsbury meeting of the Royal Agricultural Society in 1845, by Mr. George Edward Frere of Edinburgh, and attracted much attention in the field. The official report of it says:—"It is called the Norwegian Harrow or Clod-crusher, and was originally imported from Norway by Mr. Frere; the one under notice having been constructed, with some changes, by Mr. Richard Stratton, of Bristol. The acting part of this implement consists of a frame containing four horizontal spindles, on each of which is fixed a set of cast-iron bosses, with teeth projecting from them like the rowels of a spur. These teeth revolve with the spindles, those on one spindle inter-working with the others, so that they severally clear and clean each other. The effect produced is a remarkable bruizing, crumbling, or disintegration of the soil, without any clogging of the spikes, or possible derangement of the working parts. The weight suffices to cause the spikes to penetrate to the required depth, which is also governed by an adjustment of the wheels applied for travelling the implement, and for taking it out of work when turning. But it acted quite as well when divested of the wheels and of other paraphernalia, which tended rather to embarrass than assist its good action. Neither stones nor sods appear in any way to obstruct the working of this eminently simple machine, the stones being pushed aside, and the sods torn to pieces. The force was thought to be less than that required to work a common set of harrows going equal depth, and the effect in pulverization much greater. It was tried on two different kinds of soil, immediately after ploughing, with similarly good results. To what extent this implement may act as a clod-crusher the judges cannot say, as they had no means of trying it; but this distinction may be drawn between it and such an implement as Mr. Crosskill's, namely, that the Norwegian harrow leaves the land perfectly light and loose, whilst the clod-crushing roller gives to it firmness and consistence. The judges awarded to Mr. Frere a premium of £10, and Mr. Stratton obtained many useful hints from this first trial of the implement for its future improvement."—*Annual Register of Agricultural Implements.—Catalogue of the Highland Society's Museum.—Transactions of the Highland Society.—Quarterly Journal of Agriculture.—J. Allen Ransome's Implements of Agriculture. — Sir John Sinclair's Code of Agriculture.—Goodrich Smith's Economy of Farming.—Sir John Sinclair's General Report of Scotland.—Marshall's County Reports.—Mill.—Low.—Doyle.—Stephens.—Sproule.—Knowledge Society's Farmer's Series.*

HARROWING. See HARROW.

HART CLOVER. See MELILOT.

HART. The common stag,—*Cervus elaphus.* See the article DEER.

HARTOGIA. An ornamental, evergreen, Cape-of-Good-Hope shrub, of the staff-tree order. It constitutes a genus of itself, and is called at full length *Hartogia capensis.* It was introduced to Britain about half a century ago; and it grows 6 or 7 feet high, and blooms at midsummer.

HARTSHORN. Liquid ammonia. It is a solution of ammonia in pure water; and is frequently, though absurdly, called spirit of ammonia. It was formerly obtained, by a circuitous process, from the horns of the hart, and thence acquired its popular name of hartshorn; but it is now prepared by transmitting a current of ammoniacal gas into distilled water, the latter being kept cool by means of ice or of moist cloths; and the current of gas may be obtained from the action of any alkali or alkaline earth upon any salt of ammonia, but, from economical considerations, is almost always obtained from the action of lime on muriate of ammonia. Hartshorn is a limpid colourless liquid, and has an extremely acrid taste and a violently pungent smell, and acts with great corrosive power upon the skin. It consists of about one part of ammoniacal gas and nine parts of water; it quickly unites with any acid to form a hydrated neutral salt; it dissolves many of the metallic oxides; it also dissolves oils, resins, and many other vegetable principles; and it has so powerful an affinity for carbonic acid as to attract it rapidly from the atmosphere,—so that it requires to be kept well corked. It is medicinally used, in a greatly diluted state, as a stimulant, in syncope, hysteria, and paralysis,—and as a corrector of acidity in cardialgia; and, in combination with oil, it forms a pungent saponaceous rubefacient, and is applied by friction for inflammatory sore throat and for rheumatism. In veterinary practice, it is employed as an antidote to the venom of a viper's bite, and as an embrocation in rheumatic affections.

HARTSHORN SHAVINGS. The raspings of the inner part of the antlers of stags. The antlers are, not properly horns, but true bones, without pores or sinuses, and differing in substance from actual bones, only by having a smaller proportion of phosphate of lime, and a much larger one of gelatine. The raspings or shavings, when good, are insipid, inodorous, and of an ivory colour, and contain 27 per cent. of gelatine; and when boiled in water, in the proportion of one pound of the shavings and eight pounds of water, till one half of the latter is evaporated in steam, they form with it, when strained and cooled, a clear, transparent, insipid, odourless jelly, which was formerly in high esteem for combining the properties of a demulcent with those of a very light nutritious food. But though the jelly may still be used with milk for infants, or with wine and sugar for adult invalids, it can easily be superseded by cheaper and more facile preparations of gelatine. See the article GELATINE.

HART'S-TONGUE,—botanically *Scolopendrium.* A genus of ferns, of the polypody tribe. The botanical name is formed from the scientific designation of the centipede, and alludes to the appearance of the under-surface of the fronds. The common or officinal species, *Scolopendrium officinarum,* abounds on moist rocks, old walls, moist shady banks, deserted quarries, forsaken wells, and similar moist and shaded places in many parts of Britain. Its root is perennial, and tufted or somewhat creeping; its fronds are numerous, stalked, erect, lanceolate, grass-coloured, evergreen, and usually about 18 or 20 inches high; and its fructification is brown-coloured, and appears in July and August. The whole plant has an acrid and mucilaginous taste, and, when bruised, emits a very disagreeable smell. It formerly had a medicinal reputation; but it really possesses no medicinal qualities. Five distinct and permanent varieties of it occur wild,—the waved-leaved, the curled-leaved, the branchy, the many-cleft, and the narrow-leaved. —Hart's-tongue is also the popular name of a beautiful West Indian species of polypody,—*Polypodium phyllitides,*—introduced upwards of 50 years ago to British hothouses.

HARTWORT,—botanically *Tordylium.* A genus of annual weeds, of the umbelliferous order. The officinal species, *Tordylium officinale* —called, in the most recent botanical revisions, *Condylocarpus officinalis*—grows wild in the corn-fields of some parts of England. Its stem is from 10 to 30 inches high; its leaves are pinnate, rough, and hairy; its flowers are flesh-coloured, and bloom in July; and its capsules are so knobbed as to give occasion to the new name condylocarpus, signifying "knobbed fruit."—The great hartwort, *Tordylium maximum,* also infests the corn-fields of England, but is much more common than the preceding. Its stem is from two to four feet high; and its flowers are white, and bloom in June and July. Several species, but none of any interest, have been introduced from the sea-board of the Mediterranean.

HARVEST. The season of reaping field crops. It is widely modified, as to time, labour, and precariousness, by the nature of climates and the character of crops; and it acquires its maximum of importance, anxiety, and bustle, under such agricultural conditions as those of Britain, where the weather is fickle, the crops are diversified, and the arts of culture are complicated and expensive. The season for each crop varies in different years according to the comparative backwardness or forwardness of spring and summer; the season for the aggregate crops is sometimes so progressive as to allow them to be reaped in regular succession, and sometimes so sudden and headlong as to demand the most prompt and sweeping exertions; and the season for any one or more or all of the crops may either be eminently favourable to their being gathered in the finest condition, or so exceedingly adverse as to render the saving of them surpassingly difficult or all but impossible. A farmer's cares, in reference to harvest, therefore, are many and grave and almost oppressive. A large portion of his temporal interests are at stake; various methods must be practised with different crops; many minds must be controlled; multitudes of labours must be commanded and inspected; hundreds of minute and concurrent provisions, in regard to both the work-people and their work, must be made; and, after the season has commenced, all the contingencies of weather must be studied, all the vicissitudes of it watched, all the favourable influences of it strenuously followed, and all the malign effects of it conjectured and combated. When a general harvest comes hurriedly on, and the weather for it is capricious and exceedingly changeable, the farmer has daily and nightly about as much need of skill, energy, vigilance, and continual self-possession as ever Wellington had in any three months of his peninsular campaigns. Yet every really good farmer so fully anticipates the work of harvest, so thoroughly prepares for it, and so perfectly understands it, that he goes through it, in even a very trying season, with equanimity and steadiness, and promptly accommodates himself, though it were hundreds of times over, to changes of tact and prospect.

The earliest harvest of the year is that of forage-plants made into hay; the next is that of the cereal grasses,—generally in the order of rye, early barley, wheat, early oats, late barley, and late oats; and the third is that of potatoes, turnips, carrots, mangel-wurzel, and other esculent root crops. But the succession of the cereal grasses, even within the limits of Great Britain, is exceedingly modified by soil, climate, exposure, altitude, and the varieties of the several grains in cultivation; and the aggregate of harvest-work upon many farms, is greatly modified or extended by the harvesting of special or occasional crops, such as beans, flax, hemp, rapeseed, turnip-seed, teazel, canary-seed, caraway-seed, and coriander-seed. The chief of the general topics connected with harvest are noticed in the articles CALENDAR, BARN, FARM-LABOURERS, REAPING, STACK, and HAY; the principal implements used in harvest-work are discussed in the articles SICKLE, SCYTHE, HAINAULT-SCYTHE, and REAPING MACHINES; and the special methods of harvesting the several crops are noticed in the articles on the crops themselves, particularly WHEAT, OATS, BARLEY, BEANS, HAY, POTATOES, and TURNIPS.

HARVEST-HOME. A saturnalian supper, in the barn, farm-house, or other building of the farmery, at the close of the grain-harvest. It is called in Scotland a kirn or quern. It seems to have originated in heathen times; and it was long observed, in a manner of wild frolic and drunken license, far more suitable to savages than to civilized beings. Dancing, drinking, boisterous merriment, and a general oblivion of rank, station, social decorum, and religious restraint, were usually its essential characters; and injury to the moral feelings, degradation of mind, and the brutalizing of the elements of happiness, were more or less its general consequences. Even one of our highest agricultural authorities, who is misguided enough to call it, "on the whole, a cheerful rural festival," broadly states that "kirns frequently terminated in drunken frolics;" and had he reflected for a moment, he might have clearly seen that what he thus sets down as the "termination" of them was really but "the beginning of the end." Happily for the improved morality of the present day, this abomination of heathen times is now very generally suppressed.

HARVEST MOUSE. See MOUSE.

HASH. A scarifier for cutting up and renovating grass lands. It consists of a number of circular cutters adjusted upon a cylinder or common axis; and it may either be attached to the hinder part of a cart, or supported by two iron arms, and attached to the axle-tree of a pair of carriage-wheels. It cuts the surface of grass land to any required degree of fineness, and to a sufficient depth for destroying the roots of old grasses; and when it is designed to renovate the lawn or grass-field over which it passes, a box containing grass seeds is mounted above and behind, with such perforations in the bottom as to sow a line of seeds in the track made by each cutter.

HASSOCK-GRASS. See AIRA.

HATCHET-VETCH. See CORN-WEED.

HATCHING. See INCUBATION.

HATTOCK. A shock or stook of corn, with either three, six, eight, ten, or twelve sheaves.

HAUGH. An expanse of level alluvial ground, in a hill-locked valley. It corresponds, in some degree, to an English alluvial meadow; but really occurs only in the vales and valleys of a hilly country. The name haugh is exclusively Scottich; and the synonyme of it in some of the southern parts of Scotland itself is holm. See the articles CARSE and ALLUVIUM.

HAULM. The dried stems of pease, beans, potatoes, caraway, coriander, and other non-gramineous plants, cultivated for the sake of their seeds or their roots. The haulm of potatoes and some other esculent root plants is fit only for manure; but the haulm of almost all the field seed plants, even inclusive of that of beans, is more or less suitable for fodder,—some kinds of it eminently so, in its plain, ordinary, dried condition, and the most unpromising, such as that of beans, requiring only to be chopped, bruised, and steamed.

HAUNCH. The uppermost part of the hinder extremities of mammals, or the part which intervenes between the thigh and the spine. It occurs in all the mammalia except the cetacea; and is particularly prominent in the horse, the ox, the stag, and the other domesticated quadrupeds. It comprises three bones, — the ilium, which immediately connects with the spine, and is the principal member of the haunch, and extends itself prominently behind the flanks in the horse,—the ischium or hip-bone, situated behind and below the ilium,—and the pubis, which unites with the two preceding below and behind, and forms the anterior part of the girdle in front of the thighs. A wide haunch is a point of great importance in a horse, or in any other animal whose value depends upon muscular strength.

HAUSTELLUM. The suctorial organ of such insects as take in their food by suction. The insects which have this organ are often called haustellata; while insects which take in their food by a biting process, and have mandibles instead of a haustellum or sucker, are called mandibulata.

HAUTBOY. See STRAWBERRY.

HAVER. Wild or coarse oats. Haver-meal bannock, in Scotland, is coarse, thick, oaten cake.

HAW. A small piece of moveable, triangular-shaped cartilage, within the inner corner of the eye of the horse. This little organ, and the muscular power which controls it, constitute a wonderful and very beautiful mechanism for clearing the eye from impurities. It usually lies concealed within the angle of the eye; and is concave within, to suit the curvature of the eye's surface,—convex without, to suit the concavity of the lining membrane,—and thin on the edge, to suit the cleaning function which it has to perform. The haw, when summoned out by the horse to do its duty, starts out from its concealment, passes over the globe of the eye, pushes before it the dust or insect or other impurity which has entered, amasses the impurity with some lachrymal secretion, and then starts back to its place, with an action which makes the accumulation drop out. When the haw partakes of any inflammatory condition in the eye, or is hindered by such a condition from being ensconced in its usual concealment, it swells and inflames, and was mistaken by all the old farriers, and continues to be mistaken by multitudes of grooms, for a morbid tumour, under the name of "the haw in the eye." The frequent practice is to cut out this supposed tumour,—and so, ever after, to deprive the animal of the means which the benign Creator has bestowed upon him for keeping his eye free from dust; but nothing more is really needed to effect a cure than the use of a little eye-lotion.

HAW. The fruit of the hawthorn; also, a meadow or small field, *quasi* haugh.

HAWFINCH. A British bird, of the finch division of the passerinous order. Its length is between 7 and 8 inches; its beak is blue; its neck and the upper part of its head are fawn-coloured; its chin and throat are velvety black; and its back is chestnut brown. It builds its nest on the branches of lofty trees; and lays from 4 to 6 eggs, of a pale olive-green colour, spotted with black, and variegated with darkish grey. It feeds on the fruit of the hawthorn, the hornbeam, the plum, the laurel, and some other ligneous plants; and it often makes considerable depredations upon crops of ripening garden pease. It resides in Britain throughout the year; but though abundant in some localities, is rarely seen in most.

HAWK. A numerous and well-known but perplexing genus of birds, which, presenting almost endless varieties, is involved in much uncertainty of classification. Their first plumage is often differently coloured from that of the mature bird, which is not induced till the third or fourth year, or even later—a circumstance which has betrayed many ornithologists into an erroneous multiplication of the species. The female is usually about one-third larger than the male, and has been providentially endowed with superior strength because it is necessary that she should both protect and feed her voracious offspring; whereas the smaller dimensions of the male are more adapted to the rapidity and loftiness of his flight; and he is, accordingly, more esteemed by falconers. Though they are all carnivorous, they seldom feed on carrion, except when pressed by hunger, which they are capable of enduring for a long time. They have a very acute sense of sight, and pounce down on their prey with surprising force, promptitude and accuracy; manifesting, however, very different degrees of courage in pursuit of their game. Owing to their great strength, they are capable of carrying birds or other animals, nearly as heavy as themselves, to a considerable distance, sometimes forty miles or upwards, for the nourishment of their young. Many of the species eat fish, and others feed principally on the smaller birds, snakes, and reptiles. They never associate in flocks; and, except during the breeding season, even two of them are seldom seen together. Most of them build their nests or eyries in lofty and inaccessible places; but a few form them on the ground. They void by the mouth the indigested exuviæ and bones that happen to be swallowed along with their food, and which are formed in the stomach into round balls or pellets. Upwards of one hundred and fifty alleged species have been described; but of these, many are little known, and not a few are mere varieties, resulting from age, sex, climate, &c.

The Peregrine Falcon.—The *Falco peregrinus* is the largest British species of its genus, except the Iceland or Jer falcon, which, however, is of extremely rare occurrence with us, its favourite abode being the arctic regions of both continents. In the olden times it was held in the highest estimation for falconry, for although the species just mentioned was considered superior, the Peregrine was much more easily obtained, and being possessed of great docility, courage, and energy, afforded prime sport to the nobles, who alone were permitted to foster these "generous" birds, which were preserved by legislative enactments. As in other species of this family, the female is much superior in size to the male, and was used for the larger sorts of game, as herons, geese and ducks, while the latter—usually named a tiercelet, on account of its being often a third less—was flown at grouse and partridges. The male generally measures 16 inches in length, while the space between the tips of its extended wings is 36. The corresponding dimensions of the female are 22 and 45 inches. In form this species is full and robust, its neck rather short, its head large and round. The bill is shortish, thick, and strong, the upper mandible with a trigonal, acute, hooked point, and a strong process or tooth on either side. The legs are robust and short, the tarsi feathered more than half-way down; the toes strong, the second and fourth nearly equal, the first shortest, the third very long; the claws long, tapering, rather compressed, and very acute. The plumage is compact on the upper parts, softer on the lower; the wings very long, pointed, and when closed, reaching to within an inch of the end of the tail, which is slightly rounded. The bill is pale blue, with a bluish-black tip, the cere oil-green, the feet yellow, the claws black. The general colour of the upper parts is dark bluish-grey, the head blackish, the lower parts white, the breast transversely spotted with dusky. In the female the upper parts are tinged with brown, the lower are yellowish-white, with larger spots. In young birds the back is blackish-brown, the breast pale yellowish-red, with broad longitudinal spots. In all stages there is a large dark-brown or blackish patch on the side of the head or cheek.

The direct flight of the Peregrine falcon, which is extremely rapid, is performed by quick beats of the half-extended wings, and is very similar to that of the domestic pigeon. When proceeding in haste from its breeding place or roosting station towards a distant part of the country, it very seldom sails, or moves forward at intervals with extended wings; but when sauntering as it were about its retreat, it employs both modes of flight, as it also does in common with many other hawks, when searching for its prey; yet it is hardly ever seen to float along in circles, as eagles, buzzards, and harriers are wont to do, but performs its short gyrations as if in haste, and the moment an opportunity occurs, comes down upon its prey, either in a curved sweep, or like a stone falling from the air. Its food consists of birds of moderate size, such as Red grouse, partridges, plovers, ducks, auks, guillemots, and small gulls, which it pursues in open flight or pounces upon by perpendicular descent. It also sometimes attacks small quadrupeds, such as rabbits and hares. Poultry are very rarely molested by this falcon, which is by no means so ready to visit the farm-yard or its vicinity as several other species of the family. In raising birds from the water, should they prove too heavy, it sometimes drops them, and sets out in quest of others; yet it is capable of carrying a weight nearly equal to its own, and in the nest of one on the Bass-rock was found a Black grouse, which had been borne from a distance of several miles. Although a very shy and vigilant bird, it sometimes ventures to come into more immediate proximity to man than is prudent. Mr. Audubon states, that in America he has seen it fly up, at the report of a gun, and carry off a teal not thirty steps distant from the sportsman who had killed it; and other authors have made mention of similar displays of audacity.

The cry of the peregrine is loud and shrill, but is seldom heard, excepting during the earlier part of the breeding season. It nestles on high cliffs, especially those along the coast. The eggs, three or four in number, are of a broadly elliptical form, dull light red, spotted and clouded with deep red, their average length being two inches and a twelfth; their greatest breadth an inch and seven-eighths. The young, which are at first covered with close white down, are able to fly by the middle of July. In Britain it is generally distributed, but prefers mountainous or rocky situations. It has been seen in the Shetland and Orkney islands, and is occasionally met with in the Hebrides The rock of Dumbarton-castle formerly afforded a breeding place to it, as did the Isle of May. It still breeds on the Bass-rock, and there are few rocks of great height or extent on the eastern coast of Scotland on which it is not seen. Many pairs breed in the upper part of Moffatdale in Dumfries-shire. Holyhead, the Great Orme's Head, the Rock of Llandedno in Caernarvonshire, various parts of Devonshire and Cornwall, the Isle of Wight, and many other places, are mentioned as favourite resorts. According to authors, it is found over the whole of North America, in the southern division of that continent, in Australia, at the Cape of Good Hope, and in most countries of Europe.

Although a very beautiful bird, the peregrine, when perched on a rock, or flying across its face, does not present so imposing an object as one might imagine from viewing a stuffed skin in a museum, for the grey colour of its upper parts blends with the tints of the stone, and its sharp wings and rapid flight have the effect of rendering its apparent size much less than that of the buzzard. Its mode of flying differs greatly from that of the buzzards and eagles, and affords a good example of one of the most remarkable varieties. Birds which have the body bulky, and the wings short and rounded, as the grouse and partridge, have a direct flight, not generally rapid; those which have the body full, the wings long and sharp, have also a direct steady flight, but generally rapid, as is the case with the peregrine and the Rock pigeon. Birds having the body light and the wings short, as the Gallinules, also fly steadily, but with comparatively little speed. When the wings are large and broad, as in the heron, the flight is sedate, and capable of being long protracted. When they are very long and rather narrow, it is unsteady and undulating, as in some owls and gulls; and when the body is very slender, and the wings extremely long, there is produced that unsteady, bounding, gliding, and buoyant flight, so remarkable in the terns or Sea-swallows.

Besides the Jer falcon and Peregrine, there occur in Britain four smaller species of this genus, namely, the Hobby, the Merlin, the Kestrel, and the Red-legged falcon. Of the latter only five or six individuals have hitherto been met with. The hobby is also very rare; but the kestrel is, next to the sparrow-hawk, the most common of our birds of prey; and the merlin, the smallest of them, is by no means rare in Scotland, where it breeds on the moors and rocky headlands.

The Hobby.—In England, the hobby is among the number of those birds that are named polar-migrants or summer periodical visitants. It arrives in April, and after performing the offices of incubation, and of rearing its young, leaves us, for warmer latitudes, in October. Wooded and enclosed districts appear to be its usual haunts. It builds in lofty trees, but will sometimes save itself the task of constructing a nest, by taking possession of the deserted one of a magpie or crow. The number of its eggs is commonly four, of a bluish-white, with olive-green or yellowish-brown blotches. Its favourite game is the lark, but it preys upon all small birds. Partridges and quails also become frequent victims to its courage and rapacity, in which qualities, diminutive as it is, it yields to none of its tribe. Possessing a great length and power of wing, the flight of the hobby is wonderfully rapid, and can be supported with undiminished vigour for a considerable time. When hawking was keenly followed, the hobby was trained to the pursuit of young partridges, snipes, and larks. It is of elegant form, and resembles, in miniature, the peregrine falcon. The wings, when closed, generally reach beyond the end of the tail. According to Temminck, it is common throughout Europe during the summer months; but retires to warmer regions at the approach of winter.

The Kestrel.—The kestrel is distinguished, not only by the symmetry of its form and its elegant plumage, but by the peculiar gracefulness of its flight, and the manner in which it frequently remains suspended in the air, fixed, as it were, to one spot, by a quivering play of the wings, scarcely perceptible. It is one of our commonest indigenous species, and is widely spread through the kingdom. Upon the approach of spring (or the period of incubation), it resorts to rocks and high cliffs. The nest consists of a few sticks loosely put together, and sometimes lined with a little hay or wool; and is placed in some crevice, or on a projecting shelf. The eggs are from four to six in number, of a reddish-brown colour, with darker blotches and variegations.—It preys upon the different species of mice, which it hunts for from the elevated station at which it usually soars, and upon which it pounces with the rapidity of an arrow. The kestrel is easily reclaimed, and was formerly trained to the pursuit of larks, snipes, and young partridges. It is a species, in point of geographical distribution, very widely spread, being found in all parts of Europe and in America.

The Goshawk.—The goshawk is separately noticed in the article GOSHAWK.

The Sparrow-Hawk.—The sparrow-hawk, a destructive and well-known species, is remarkable for the great difference in size between the male and female; the former seldom measuring twelve inches in length, whilst the latter often exceeds fifteen inches. It is one of the boldest of its genus, and the female, from her superior size, is a fatal enemy to partridges and other game, as well as pigeons. It flies low, skimming over the ground with great swiftness, and pounces its prey upon the wing with unerring aim. The force of its stroke is such as generally to kill, and sometimes even to force out the entrails of its victim. It is common in most parts of the kingdom, but particularly frequents the lower grounds, and well-wooded enclosures. It builds in low trees, or thorn-bushes, forming a shallow and flat nest, composed of slender twigs, and very similar to that of the ring-dove but rather larger. It will occasionally occupy the deserted nest of a crow. The sparrow-hawk is very widely diffused, and found in all parts of Europe. In the days of falconry it was trained, and much approved in the pursuit of partridges, quails, and many other birds.

HAWKBIT. See APARGIA.

HAWKES. See BLAIN.

HAWKLING. See HAWKWEED.

HAWK'S-BEARD. See CREPIS.

HAWKWEED,—botanically *Hieracium.* A large genus of herbaceous plants, of the succory division of the composite order. Seventeen species grow wild in Britain; upwards of one hundred species have been introduced from other countries, principally in Continental Europe; and at least a score of other species have been described. A few of the species have simple, one-flowered scapes; a few have many-flowered scapes, and generally a scanty foliage; about a score are stoloniferously creeping; and the rest, whether their leaves be runcinate, serrate, or entire, are readily distinguishable from the other three groups by the comparative leafiness of their stems. All the species in Britain, native and exotic, with but one exception, are perennial-rooted; all, with three or four exceptions, are yellow-flowered; all, with one exception, are quite hardy; and the plainest have a considerable proportion of coarse beauty, while many are handsome, and a few are elegant, and well worthy of a place in the flower-garden. Most of the indigenous species occur in such situations as to be ornaments to the landscape, and not weeds in the field; and one very beautiful species, *H. umbellatum*, has been successfully used for yielding a good and permanent dye.

The alpine hawkweed, *H. alpinum*, grows on mountainous rocky situations, is usually 6 or 8 inches high, has a one-flowered scape, and carries a yellow bloom in July and August.—The ear hawkweed, *H. auricula*, grows on the mountains of England, but not of Scotland, is 20 inches high, has a stoloniferously creeping habit, and blooms in July and August.—The orange hawkweed, *H. aurantiacum*, grows in the woods of Scotland, but not of England, is 20 inches high, has a stoloniferously creeping habit, and carries orange-coloured flowers in June and July.—The doubtful hawkweed, *H. dubium*, is a dwarfish and beautiful, stoloniferous, yellow-flowered native of the hills of both England and Scotland, and blooms at the end of summer.—The mouse-ear hawkweed, *H. pilosella*, inhabits dry pasture grounds, is 6 or 8 inches high, and stoloniferously creeping, and produces beautiful yellow flowers from May till July.—Lawson's hawkweed, *H. Lawsoni*, is a handsome, dwarfish, scarce, many-flowered native of the north of England, blooming in June and July.—The toothed and the soft hawkweeds, *H. denticulatum*, and *H. molle*, are leafy, yellow-flowered natives of the woods of Scotland, about a foot high, and blooming at the end of summer.—The prenanthus-like hawkweed, *H. prenanthoides*, is 24 or 30 inches high, and inhabits the banks of Scottish streams, and is sometimes mistaken for the toothed species.—The spotted, the wood, the wall, the lungwort and the cerinthe-like hawkweeds, *H. maculatum*, *H. sylvaticum*, *H. murorum*, *H. pulmonarium*, and *H. cerinthoides*, are leafy, yellow-flowered natives of rocky situations, blooming at the end of summer, and usually about 20 inches high, all five in Scotland, but only the three first in England.—The villous hawkweed, *H. villosum*, is a beautiful, yellow-flowered native of the rocky parts of lofty Scottish mountains, about a foot high, and blooming in July and August.—The umbelled and dye-yielding hawkweed, *H. umbellatum*, inhabits the woods of both Scotland and England, has a leafy stem, grows 3 or 4 feet high, and carries yellow flowers from July to September.—The most ornamental of the exotic species are *H. foliosum, longifolium, subaudum, bracteolatum*, and *canescens*.

HAWORTHIA. A genus of small, curious, grotesque, evergreen, herbaceous, Cape-of-Good-Hope plants, of the aloe division of the day-lily order. About seventy species have been introduced to the hothouses and greenhouses of Britain; and these vary in height from 3 to 18 inches, and have the same succulent, fleshy, greyish, odd-looking appearance as the gasterias and the apicras, and assort well with the most grotesque of the echinocacti, melocacti, and mamillarias. The clammy species, *H. viscosa*, is both the longest known and the tallest, and was classed by Linnæus as a true aloe, under the name of *Aloe viscosa*. See the article ALOE.

HAWTHORN,—botanically *Cratægus*. A large and important genus of hardy, ligneous, ornamental, and useful plants, of the apple-tree division of the rosaceous-flowering order. Two species—one of them comprehending very many varieties—grow wild in Britain; about 50 have been introduced from other countries; and a few more have been described. All are naturally either tall shrubs or small trees, of from 10 to 25 feet in height; the leaves of most are much cut and serrated; the flowers of all grow in corymbs, and, with the exception of one or two varieties, are white-coloured; the bracteas are subulate and deciduous; the calyx has an arceolate tube, and a five-cleft limb; the petals are round and spreading; the ovarium is from two-celled to five-celled; the styles vary in number from one to five, and are glabrous; and the fruit is a small, fleshy, ovate pome, closed by the calcined teeth or thickened disk, and containing a hard bony putamen. Two species, inclusive of some varieties, are evergreen; and all the other species, exclusive of two or three of their varieties, are deciduous. The popular name hawthorn alludes to the fruit and the spines of the plants,—the former called haws, and the latter so strong and numerous as often to occasion the plants to be called 'thorns' distinctively or par excellence; and the botanical name cratægus is formed from a Greek word signifying 'strength,' and alludes to the hardness and durability of the timber.

The hawthorns excel all other genera, and even all other families, of tall shrubby plants, both in the number of their objects of individual beauty, and in the great scope and high picturesqueness of their variety of habit. They comprise almost all the shapes and figures which the eye of taste pronounces elegant in shrubs; and most of them combine with their elegance of form great beauty of both flower and fruit. "Who," says a periodical writer, "is not charmed with the simple beauty of the 'May,' blooming, as it does, the harbinger of summer? Who is not gratified by its peculiar fragrance, when inhaled with all the freshness of a spring-tide morning? Who is not pleased, again, to see the countless haws upon the hawthorn boughs, rivalling even the berries of the holly in their crimson hue, and decking the leafless branches with all the pride of plenty? Surely none. All, even the most superficial observers, share in the general satisfaction. But these are popular feelings,—incited perhaps by some mighty inward principle, but still inexplicable. Yet the eye of taste is equally captivated by less glaring and prominent though equally characteristic features to be found among the 'thorns.' The varied outline and aspect of the different kinds, the many forms and figures to be found among their foliage, the charming colour of the flowers of some, the different tints of their fruit,—these and such characters are sufficient to elicit the approbation of those who look deeper than the surface of things." "Whether as small trees or as shrubs," says Loudon, "they are all admirably adapted for planting grounds of limited extent, and especially for small gardens in the neighbourhood of large towns. They are not only highly beautiful when in flower,—a period which extends from the beginning of April to the end of July, commencing with *C. purpurea*, and ending with *C. cordata*,—but also when they are covered with ripe fruit,—which includes a period commencing with *C. purpurea* and *C. nigra* in the beginning of July, and continuing till the following spring and summer, *C. mexicana*, *C. virginica*, and some other species retaining their fruit all the winter. Of all the genera of hardy, deciduous, ligneous plants in cultivation in British gardens, there is not one which, taking it altogether, can be compared with the genus Cratægus."

Hawthorns are favourite plants of all classes of our population, from the peasant to the prince, from the hobnail to the savan, and from the little child to the octagenarian; yet though everywhere common, and universally familiar, they possess such lofty beauty and powerful fascination as never to become vulgarized or to suffer neglect. They seem also to have been general favourites in all ages of mankind; and they have identified themselves with many a popular observance, whether poetical, festal, or superstitious. Hawthorn boughs were carried by the brides of Athens to the hymeneal altar; hawthorn flambeaux were burned both at that altar and in the nuptial chamber; hawthorn flowers and branchlets were carried by the Athenian girls to adorn their companions and friends; and hawthorns, in connexion with such usages as these, were regarded by the Athenian people as the emblem of hope. Hawthorn flowers and boughs were treated in a similar festal and symbolical manner by the Romans. Garlands, wreaths, and festoons of hawthorn flowers were hung and twined by the ancient Anglo-Saxons and by the English of the middle ages, and of almost modern times, upon the summit and shaft of the maypoles, at the rural merrymakings on the first of May; and "this rustic amusement," we are told, "was evidently introduced by the Romans, as we see in it the remains of their ancient games, Floralia, that were instituted in Rome as early as the time of Romulus, and which the Phoceans and Sabines observed in even earlier days." Hawthorns are superstitiously believed, by the peasantry of some parts of France, to emit sighs and groans on Good Friday, and to be protections against lightning; and they are, therefore, regarded as the emblem of lamentation, and bunches of them are worn in the people's hats during thunderstorms.

The common hawthorn or whitethorn, *Cratægus oxyacantha*, called by some botanists *Mespilus oxyacantha*, is indigenous in hedges, copses, thickets, and high open fields in Britain, and also grows wild over all Europe. It is naturally a tall, uncouth, irregular shrub, of about 15 feet in height; but, in many situations, it assumes widely different forms, and comprises a great number of perfectly distinct varieties; and when trained up as a standard, on the most congenial soil, it becomes a tree of 40 or 45 feet in height, with a tall stem, and a full, spreading, round head. It eminently possesses the capacity, which is common in some degree to all the species, of either assuming a strictly dendritic character, with naked trunk and arm-like branches, or of sitting close to the ground as a dense bush, without any visible or obvious stem, and with an almost equal density of branchlets and spray and spines from the root-crown to its loftiest series of shoots. Mr. Marshall mentions a young thriving hawthorn, with a clear stem 8 feet high and 5½ feet in girth; Mr. Marsham speaks of one in the vicinity of Norwich, whose stem in 1755 was upwards of 9 feet in girth at 4 feet from the ground, and one of whose arms extended upwards of 21 feet; and a well-known hawthorn at Duddingston, in the vicinity of Edinburgh, in 1836, measured 10½ feet round the stem a little above the roots, 9½ feet round the stem at 3 feet from the ground, and had a total height of 43 feet, and a diameter of 44 feet through its head. But the plant admits of being trained into almost any form; and it yields so hardily and patiently to the discipline of training as to retain, in even the most repressive and contorting circumstances, a large proportion of its native grace and elegance. In its grand uses as the favourite material for hedges, too, "it branches out into innumerable ramifications, and is armed in all directions with strong thorns, and may be so managed as to present a barrier impenetrable to any kind of cattle, and not without difficulty to be passed over by such disorderly persons as might wish improperly to intrude upon the rights of others. Fitted by nature to assume a close and compact texture, which it possesses most fully during the expansion of its leaves, but retains too, in a considerable degree, after these have fallen off, it is not without the advantage of breaking the force of stormy winds, and mitigating the severity of the weather in favour of the vegetable and animal life which it is appointed to enclose." See the article HEDGE.

The stem and branches of the common hawthorn, as to comparative erectness and mutual disposition and aggregate habit, differ somewhat widely according to the varieties of the species; but the stems of the kinds most suitable for hedges are stiff, erect, parallel and close to one another, and clothed with smooth and shining bark. The spines also are various; but those of the good hedge kinds are sharply pointed, of medium length, and of dark purple colour. The leaves likewise are considerably diversified; but those of most of the varieties are obovate-cuneiform, glabrous, shining, and deeply cut into trifid and pinnatifid divisions. The flowers are corymbose and richly fragrant, and, except in a few varieties, are white; the calyxes are acute and glandless; and the fruit, like most of the other features, has a various character, but in most instances is nearly insipid and has a dark-red colour.

The timber of the common hawthorn has a white colour, with a yellowish tinge; and it has a fine grain, and takes a beautiful polish; but it is very hard, difficult to work, and liable to warp,—and it seldom can be obtained in sufficient volume for any of the ordinary purposes of carpentry,—and it is, therefore, comparatively little used in the arts. It is employed principally for walking-sticks, flails, hammer-handles, mallets, the teeth of mill-wheels, and clubs for playing at golf. The freshly-lopped branches burn almost as freely as the dried wood, and give out great heat during combustion; so that they make good fuel, and are used in England for heating ovens. Whenever a felled stem is intended to be used for timber, it ought to be immediately cut into planks and dried; for if allowed to lie some time uncut, it will rapidly undergo incipient eremacausis, and become brittle and worthless. The roots were formerly used for making combs. The fruit is eaten by the peasantry and by children in Britain and other countries; it is greedily devoured by gallinaceous game-fowls and by many other kinds of birds; and it is employed by the inhabitants of Kamtschatka for making a sort of wine.

So many as 30 distinct and permanent varieties of the common hawthorn are mentioned in Loudon's 'Hortus Britannicus;' probably as many more are known to some nurserymen; and fugitive or seedling varieties are so multitudinous as to be past reckoning. We shall succinctly notice some of the most distinct and best known varieties.—The zigzag hawthorn, *C. o. flexuosa*, grows in a spreading manner, is naturally about 15 feet high, and has its smaller branches curiously twisted in the way of zigzag.—The early-flowering hawthorn, *C. o. præcox*, originated long ago at Glastonbury, and is separately noticed in the little article GLASTONBURY THORN.—The woolly-fruited hawthorn, *C. o. eriocarpa*, grows wild in the woods of Britain, is naturally a small robust tree of about 15 feet in height, has a spreading habit and large leaves, is one of the latest varieties in exfoliating, is very prolific in flowers, and has its fruit woolly when young and red when mature.—The beaded-flowering hawthorn, *C. o. capitata*, has an erect habit, and differs from the preceding chiefly in being less spreading or more fastigiate, and in producing its flowers in close heads at the extremity of the branches. The Siberian or one-styled hawthorn, *C. o. sibirica* or *C. o. monogyna*, was introduced to Britain from Siberia, has a dwarf spreading habit, and in mild seasons comes very early into leaf, and sometimes flowers in January. The yellow or golden-fruited hawthorn, *C. o. flava* or *C. o. aurea*, has a dwarf and spreading habit; and its fruit is roundish, golden-yellow, and remarkably sweet, and hangs on the tree throughout the winter. The double-flowering hawthorn, *C. o. flore-pleno* or *C. o. multiplex*, is a very beautiful plant, with a compact habit, and white double flowers, which, in some situations, die off a pinkish or reddish colour. The shining-leaved hawthorn, *C. o. lucida*, is probably the single-flowering variety of the preceding. The obtuse-lobed hawthorn, *C. o. obtusata*, was introduced to Britain about 25 years ago from France, and has rather a spreading habit, and small, flat, shining leaves. Cels's hawthorn, *C. o. Celsiana*, occurs only in gardens and shrubberies, and has a slender fastigiate habit. The yellow-variegated-leaved hawthorn, *C. o. foliis aureis*, belongs also to gardens, and is distinguished by the yellow variegation of its foliage; but though its leaves are showy when unfolding, they afterwards look ragged and diseased. The white-variegated-leaved hawthorn, *C. o. foliis argenteis*, belongs likewise to gardens, and is distinguished by the white variegation of its foliage. The oak-leaved hawthorn, *C. o. quercifolia*, was introduced to Britain about 14 years ago from north-western Germany, and has a robust growth, an erect habit, and red fruit. The Transylvanian hawthorn, *C. o. transylvanica*, holds a doubtful place between the oak-leaved and the Siberian varieties. The cut-leaved hawthorn, *C. o. laciniata*, was introduced about 30 years ago from Sicily, and has a very slender growth and a somewhat pendulous habit, and is one of the earliest in exfoliating. The brake-leaved or pectinated hawthorn, *C. o. pterifolia* or *C. o. pectinata*, is nearly allied to the preceding. The pendulous hawthorn, *C. o. pendula*, is a hybrid, has a drooping habit, an elegant outline, and red fruit, and is early in exfoliating. Queen Mary's thorn, *C. o. regina*, originated in the gardens of Scotland, and resembles the pendulous in habit and elegance, and usually attains a height of about 30 feet. The upright hawthorn, *C. o. stricta* or *C. o. rigida*, is a hybrid of little more than 20 years' standing, and has a very marked fastigiate habit similar to that of the Lombardy poplar. The roseate-flowered hawthorn or Pink-May or scarlet thorn, *C. o. rosea*, occurs wild in the hedges and thickets of Britain, and has purple-coloured flowers, and has long been well known and universally admired. The scarlet-flowered hawthorn, *C. o. punicea*, *C. o. elegans*, or *C. o. rosea superba*, differs from the roseate-flowered in having a darker and richer red in its flowers The double-flowered scarlet-blossomed hawthorn, *C. o. punicea flore-pleno* or *C. o. rosea flore-pleno*, differs from the preceding in the doubleness of its flowers, and may be probably regarded, when in bloom, as the most beautiful plant of the whole hawthorn genus. The black-fruited hawthorn, *C. o. melanocarpa*, *C. o. fissa*, or *C. o. platyphylla*, was introduced nearly 30 years ago from Tauria, and has a robust growth, a spreading habit, black fruit, and an ordinary height of about 20 feet. The sharp-leaved hawthorn, *C. o. oxyphylla*, was found in a bed of seedlings at Somerford Hall, and has small leaves, and a very slender, diffuse, and somewhat pendulous habit, and is one of the most graceful and handsome of the whole family. The purple hawthorn, *C. o. purpurea*, is a British hybrid, and is distinguished by the purple colour of its shoots. The eastern or Oliver's hawthorn, *C. o. orientalis* or *C. o. Oliveriana*, was introduced nearly 30 years ago from Asia Minor, and has white blossoms and an ordinary height of about 20 feet. The orange hawthorn, *C. o. aurantiaca*, originated in Ayrshire, and is distinguished by the orange colour of its fruit. The white-fruited hawthorn, *C. o. leucocarpa*, grows wild in Britain, and has whitish-coloured haws.

The other species of hawthorn now in Britain deserve, in the aggregate, fully more attention than even the varieties of the common hawthorn. Collections of specimens of both the species and the varieties are now practically regarded as one of the most beautiful and appropriate departments of arboretums, public gardens, and public nursery-grounds; and very fine and extensive ones may be seen in places where they themselves constitute one-fourth or one-third of all the ligneous plants within the grounds; while several complete and quite normal ones have been formed, particularly in the garden of the London Horticultural Society, and in the grounds of Messrs. Loddiges, the eminent nurserymen of Hackney. All the species may be comprehensively reduced to seven classes,—the Oxyacanthæ, or those which agree in general characters with the common hawthorn,—the Microcarpæ, with spines few and large, flowers small, corymbous, and very late in blooming, and fruit small, round, and red,—the Aroniæ or Azaroli, with few or no spines, shining, pubescent, wedge-shaped, three-cleft or many-cleft leaves, and large, round or pear-shaped, red or yellow, eatable fruit,—the Coccineæ, with tall stem, vigorous growth, cordate, lobed, acutely-serrated leaves, large flowers, and large fruit,—the Crus-Galli, with very large and cockspur-like spines, unlobed leaves, and small or moderately-sized fruit, passing at the period of maturation from dark-green to red,—the Parvifoliæ, with small, ovate, notched or serrated or but very slightly lobed leaves, and hard, moderately large, green or greenish-yellow fruit,—and the Pyracantha, with evergreen, small, entire, glabrous, ovate-lanceolate leaves, and numerous, bright coral-coloured fruit.

The Oxyacanthæ, strictly understood, are all comprised in the varieties of the common hawthorn; but they may also comprise five species which some botanists insist upon regarding as four separate subgenera.—Douglas's hawthorn, *C. Douglasii*, was introduced about 16 years ago from north-western America. Its stem is erect and from 10 to 15 feet high; its spines are rigid and rather numerous; its leaves are obovate, unlobed, saw-edged, and shining, and they are very late in exfoliating in spring, and become leathery and purplish in autumn; its flowers grow in middle-sized bunches, and bloom in May; and its fruit are small, dark-purple, with soft and watery pulp, and drop off soon after they become ripe.—The parsley-leaved hawthorn, *C. apiifolia*, grows wild in the moist woods of Virginia and Carolina, and was introduced about 35 years ago to Britain. Its stem is from 10 to 20 feet high; its growth is weak; its habit is loose, straggling, and somewhat pendulous; its spines are few; its leaves are deltoid, and deeply lobed; its flowers grow in small bunches, and are middle-sized, and bloom in May and June; and the fruit are scarlet.—The various-leaved hawthorn, *C. heterophylla* or *C. neapolitana*, was introduced about 30 years ago from North America. Its stem is from 10 to 20 feet high; its habit is dense-headed and fastigiate or pyramidal;

its leaves have a great diversity of form, but are usually lanceolate-cuneate, and three-cleft at the apex; its flowers grow in moderately-sized bunches, and are large and numerous, and bloom in May; and its fruit have a rich crimson colour, and are narrower and longer than those of the common hawthorn. This species exfoliates early in spring, and retains its foliage and its fruit till very late in autumn; and both it and the two following species are spineless. —The black-fruited hawthorn, variously called *C. nigra*, *C. carpatica*, and *Mespilus nigra*, is a native of Hungary, and has now been nearly 30 years in Britain. Its height is from 20 to 30 feet; its habit is massive, handsome, and somewhat fastigiate; its leaves are somewhat wedge-shaped, sinuately lobed, and whitish below, and often exfoliate in March or February; its flowers grow two or three in a bunch, and are small, and bloom in April or May; and its fruit are black.—The purple-branched hawthorn, *C. purpurea* or *C. sanguinea*, was introduced about 25 years ago from the Altaic mountains. Its height is about 10 feet; its growth is rather slow; its habit is upright and rigid; its flowers are small, and grow in middle-sized bunches, and bloom earlier than those of any other hawthorn except the Glastonbury thorn; and its fruit are small, round, and usually dark purple. A variety of it is called *C. altaica* or *C. p. altaica*.

The small-fruited hawthorn, forming the type of the Microcarpæ, and called variously *C. microcarpa*, *C. spathulata*, and *C. florida*, is a native of the upper districts of Georgia and Carolina, and has now been about 40 years in Britain. Its stem is from 8 to 15 feet high; its growth is rather slow; its habit is spreading and somewhat drooping; its leaves usually grow in clusters, and are oblong-spathulate, bluntly three-lobed, shining, smooth, and handsome, but are very late in exfoliating; its flowers grow in middle-sized bunches, and are small, and bloom in May and June; and its fruit are small, bright-red, and inconspicuous. — The heart-leaved hawthorn, called variously *C. cordata*, *C. acerifolia*, *C. populifolia*, *C. phænopyrum*, and *Mespilus acerifolia*, is a native of hedges and rocky places throughout the greater part of North America, and was brought to Britain in the fourth decad of last century. Its stem is erect and from 15 to 25 feet high; its habit is compact and close-headed; its leaves are cordate-ovate, angularly lobed, shining, and deep green, and vary greatly in size; and its flowers grow in numerous, large, terminal corymbs, and do not bloom till June.

The aronia hawthorn, *C. aronia*, *C. fissa*, or *Mespilus aronia*, constituting the type of the subgenus Aroniæ, is a native of Greece and the Levant, and has now been nearly 40 years in Britain. Its height is from 15 to 20 feet; its habit is erect and dense; its leaves exfoliate early and are deeply cut; its flowers grow three and four in a bunch, and bloom about the end of May; and its fruit are large, yellow, and rather pleasantly esculent.—The tansy-leaved hawthorn, *C. tanacetifolia*, *C. pinnata*, or *Mespilus tanacetifolia*, is a native of Greece, and was introduced about 60 years ago to Britain. Its height is about 15 feet; its growth is robust; its habit is fastigiate, with upright rigid branches; its leaves are pinnatifid, and deeply cut, and are late in exfoliating; its flowers are large, but are few-flowered in the bunch, and bloom in May and June; and its fruit are globular and yellowish-green. Three varieties of it, — the smooth, from Germany, — Lee's, a hybrid, — and Cels's, somewhat similar to the eastern hawthorn,— are in cultivation.—The Morocco hawthorn, *C. maroccana*, is a native of Morocco, of Palestine, and of Mount Sinai, and has now been about 25 years in Britain. It is one of the most handsome trees of the whole family; and resembles the azarole, but is smaller in all its parts, and more fastigiate. Its leaves are three-lobed, and exfoliate in mild seasons in January, and continue till very late in autumn; its flowers grow in rather small bunches, and are pure white and very fragrant, and bloom in May and June; and its fruit are yellowish-red.—The azarole hawthorn, sometimes called the azarole medlar and the azarole pear-tree, is noticed in the article Azarole.—The eastern hawthorn, *C. orientalis* or *C. odoratissima*, is a native of the Levant, and has now been nearly 40 years in Britain. Its height is from 15 to 20 feet; its habit is low and spreading, with loose, rather pendulous, and very hoary branches; its leaves are late in exfoliating, and deeply cut; its flowers are large, and grow in small bunches, and bloom in May and June; and its fruit are coral-coloured, very agreeably tasted, and so profuse and brilliant as to render the tree highly ornamental. An exceedingly handsome variety of it, *C. o. sanguinea*, has blood-coloured fruit.—The Mexican hawthorn, *C. mexicana*, *C. stipulacea*, or *C. Lambertiana*, is a native of the high table-lands of Mexico, and has now been about 24 years in Britain. It differs sufficiently from the other Aroniæ or Azaroli to be regarded by some botanists as constituting a subgenus of its own. It is evergreen when planted against a wall, and subevergreen as a standard in most situations around London. Its height is from 10 to 15 feet; its growth is vigorous; its habit is rather spreading; its leaves are large, oval-lanceolate, notched, and serrated; its flowers grow in large, dense bunches, are large and white, and bloom in June; and its fruit are large, green or yellowish-green, and similar in appearance to small apples, but scarcely palatable,—and, in sheltered situations, they remain, with the leaves, throughout the winter.

The scarlet-fruited hawthorn or Virginian azarole, *C. coccinea*, *C. æstivalis*, or *Mespilus coccinea*, constituting the type of the subgenus Coccineæ, is noticed in the article Azarole. Four varieties of it, additional to the normal plant, are in cultivation,—the largest-leaved, from France, the coralline, with fruit of a fine coral colour, the Neapolitan, and the indented-leaved or the Georgian.—The glandular hawthorn, *C. glandulosa*, *C. rotundifolia*, *Pyrus glandulosa*, or *Mespilus rotundifolia*, is a native of Canada, the Alleghanies, and the Rocky Mountains, and was introduced to Britain about the middle of last century. Its height is from 12 to 15 feet; its growth is slow; its habit is low, compact, bushy-headed, and somewhat conical; its leaves are obovate, but have a cuneate base; its flowers grow in rather small bunches, and bloom in May and June; and its fruit are oval and scarlet. Four varieties of it are in cultivation,—the subvillous, the succulent-fruited, the small-fruited, and the long-spined. — The dotted-fruited hawthorn, *C. punctata* or *Mespilus cuneifolia*, is a native of the woods and swamps of Virginia and Carolina, and has now been in Britain about a century. Its height is from 15 to 30 feet; its habit is spreading and nearly horizontal; its flowers are large, and grow in small bunches, and bloom in May and June; and its fruit are large, red, and dotted. Four varieties of it, all brought from North America, are in cultivation, the red-fruited, the golden-fruited, the upright-red, and the short-spined.—The pear-tree-leaved hawthorn, *C. pyrifolia*, *C. radiata*, *C. flexuosa*, *C. tomentosa*, *C. latifolia*, *C. cornifolia*, or *C. leucophlæos*, is a native of woods and rocky grounds from Pennsylvania to Carolina, and has now been about 80 years in Britain. Its height is about 20 or 25 feet; its habit is spreading; its branches are much twisted and generally spineless; its leaves are ovate-elliptical, deeply indented, and exceedingly large, but fall very early; its flowers grow in large bunches, and are small, and bloom in June and July; and its fruit are small and yellowish-red.

The cockspur hawthorn, *C crus-galli*, *C. lucida*, *C. hyemalis*, or *C. cuneifolia*—and regarded by some botanists as a medlar, with the same uncertainty or diversity of specific name—grows wild in woods and hedges and on the banks of rivers, from Canada to Carolina, and was introduced to Britain toward the close of the 17th century. In sheltered situations in the south of England, it is a subevergreen. Its height is from 15 to 20 feet; its leaves are obovate-cuneate; its flowers grow in pretty large clusters, and are small, and bloom in May and June; and its fruit are small and scarlet. Seven distinct and permanent varieties of it, all North American,—the pyracantha-leaved, the willow-leaved, the linear-leaved, the dwarf, the shining, the oval-leaved, and the plum-tree-leaved,—are in cultivation; but the two last are sometimes regarded as separate species. —The oval-leaved hawthorn, *C. ovalifolia* or *C elliptica*, was introduced about 36 years ago. Its height is about 30 feet; its habit is loose and spreading; its branches are very sparingly set with spines; its leaves are broad and oval; its flowers are large and in middle-sized bunches, and bloom in May and June; and its fruit are red.—The plum-tree-leaved hawthorn, *C. prunifolia*, *C. caroliniana*, or *Mespilus prunifolia*, was introduced about 30 years ago. Its height is about 20 feet; its habit is compact and somewhat erect or fastigiate; its leaves are ovate; its flowers are small, and grow in small bunches, and bloom in May and June; and its fruit are red.

The small-leaved hawthorn, *C. parvifolia*—called also a Cratægus with eight other specific names, and a Mespilus with four specific names—is a native of sandy shady woods from New Jersey to Carolina, and has now been upwards of 140 years in Britain. Its height is from 4 to 6 feet; its habit is dwarfish, rigid, and bushy; its leaves are small oval-lanceolate; its flowers grow singly at the end of the twigs, and bloom late in May and in June; and its fruit are large and yellowish-green. Two varieties of it, the gooseberry-leaved and the Floridan, are in cultivation.—The Virginian hawthorn, *C. virginica*, was introduced about 35 years ago from Virginia. Its height is 4 or 5 feet; its leaves are small and obovate-cuneate; its flowers grow at the end of the shoots, and bloom in May and June; and its fruit are round and green.—The yellow-fruited hawthorn, *C. flava*, *C. flavissima*, *C. caroliniana*, or *Mespilus Michauxii*, grows wild from Virginia to Carolina, and has now been in Britain upwards of 120 years. Its height is from 15 to 20 feet; its growth is rapid; its habit is spreading; its branches are horizontal; its bark is rough; its leaves are obovate-cuneate; its flowers are large, and chiefly solitary, and bloom in May; and its fruit are top-shaped and yellow or yellowish-green.—The lobe-leaved hawthorn, *C. lobata*, *C. lutea*, or *Mespilus lobata*, much resembles the preceding, but carries its flowers in loose corymbs, and has green fruit.—The three-lobed-leaved hawthorn, *C. trilobata*, or *C. spinosissima*, is a hybrid of about 26 years standing. It resembles the yellow-fruited species, but is thornier, and has less vigorous branches, produces its flowers in considerable bunches, and displays a tinge of red upon its yellow fruit.

The pyracantha or fiery thorn or evergreen thorn, *C. pyracantha* or *Mespilus pyracantha*, is a native of Italy and the south of France, and was introduced to Britain in the first half of the 17th century. It grows, as a standard, to the height of from 4 to 10 feet; but has a spreading and somewhat straggling habit, of such a kind as fits it for being trained against the wall of a house. "It is chiefly used," says Marshall, "to ornament or hide the ends of houses, barns, stables, or other buildings that break in upon the view; and for this purpose no plant is better adapted, as, by its evergreen leaves, closely set, it will not only keep from sight whatever cannot regale that sense, but will be to the highest degree entertaining by the profusion of berries it will produce, and which will be in full glow all winter." Its branches are very flexible in wall-training, but are stronger and more woody in standard growth; its bark is smooth, and of a dark greenish-brown colour, often variegated with greyish spots; its leaves are small, oval-lanceolate, entire, and glabrous; its flowers grow in corymbous bunches, and bloom in May; and its fruit are produced in large glowing bunches, and have a bright coral or fiery red colour. A variety of this species, called *C. p. crenulata*, or *Mespilus crenulata*, was introduced about 26 years ago from Nepaul.

All the hawthorns flower abundantly and produce seed freely in the neighbourhood of London; and all may, at pleasure, be propagated in the natural course from seeds; but, in general practice, the common hawthorn alone is grown from seeds, and the other kinds are grafted or budded upon its stocks. All succeed best in a free open soil, of moderate depth, above a tolerably dry subsoil; yet all succeed well enough for the purposes of small ornamental trees in almost any kind of soil which is either naturally dryish or artificially drained. But in marshy situations, few if any will at all thrive; and in the vicinity of water, they become covered with moss and lichens; and beneath the drip of trees or in minglement with other plants, they will either refuse to grow or be sickly and dwarfish.

The gathered haws, if put in heaps, are very liable to heat and to lose their vitality; and if packed and carried, as they frequently are, in large hogsheads, they sometimes so exceedingly spoil, that not more than one in twenty will germinate. They do not naturally germinate in the ground till the second year; and, therefore, the nurserymen, in order to decompose their pulp, and accelerate their development, mix them with sandy earth in flat heaps of 9 or 10 inches in depth, and frequently turn these to prevent the haws from heating. A common practice is to bury them in an earthen pit, or to leave them in a mixed heap with a considerable bulk of sand during a whole year, and then, in October, to take them up and sow them; and a preferable practice, recommended by old Hanbury, is to sow them in prepared beds as soon as they are gathered. The seedlings may be transplanted after either the first or the second year's growth, according to convenience; and they should afterwards, if standing upon nursery ground, be transplanted from time to time till they become placed in their final destination.

The stocks of the common hawthorn are so free-growing, so abundant, and so thoroughly accommodating as to suit admirably for the grafting or budding of all the ornamental varieties and species in cultivation. "All these," says the periodical writer formerly quoted, "thrive so freely when worked in this manner, and display their individual and natural characteristics so fully, that we see no ground of objection to this mode of propagation, since it does not affect their habit, as it does that of some other plants. A decided advantage is sometimes realized, in consequence of being able to select strong and well-established stocks; for by this means much larger plants are attained within a given space of time, than by any other method of propagation which would dispense altogether with this extraneous aid. Of the operation itself, it is only necessary to say, that they are grafted or budded in the ordinary way upon stocks previously prepared, and cultivated, so as to be furnished with an abundance of fibrous roots; they are either worked near the ground, and the young shoot trained up to a sufficient height, and then pruned so as to form the head; or the stock is trained with a straight stem to a sufficient height, and then worked. The ultimate result in either case is the same; though the latter is the most expeditious method of forming the head. For dwarf and bushy plants the training to form a leading stem is dispensed with, and the young shoots pruned back a little for a season or two, after which they should in all cases be allowed to assume their own peculiar way of growth, except some other definite object be in view. In cases where any branch may grow out in an awkward and straggling manner, it is so far desirable to apply the pruning knife as to remove this objectionable tendency, but nothing more. Whether intended for dwarf bushy plants, or for standard ones, the young shoots, produced direct from the graft, must be pruned back for one or two seasons, in order to form the head of the plants sufficiently thick of branches. At this stage, any badly placed or cross shoots ought to be cut out altogether, and the rest shortened back about half their length; this treatment may be repeated the next season; and again, less rigorously in the following one; and it will seldom happen that much subsequent pruning will be needed. This work belongs properly to nursery culture. In most cases, it will be by far the easiest plan to procure young plants from the nurseries, instead of attending to these operations personally; especially as the plants are generally by no means expensive ones." —*Marshall on Planting.—Nicol's Planter's Calendar.—Miller's Gardener's Dictionary.—Loudon's Arboretum et Fruticetum Britannicum.—Loudon's Hortus Britannicus.—Highland Society's Transactions.—Phillip's Sylva Florifera.—The Horticultural Magazine.*

HAY. Dried herbage for the feeding of horses and other domestic animals. It may consist either wholly of grasses, or principally of grasses, or mixedly of grasses and other herbage plants, or characteristically of the forage-plants grown in the rotational husbandry, particularly of tares and clovers; and it formerly constituted the grand means, and still constitutes a bulky and important one, of the winter-feeding of the large quadrupeds of the farmery and the city.

The Different Kinds of Hay.—One kind of hay consists of the dried produce of naturally wet or marshy meadows; and this comprises many varieties,—some consisting merely of the very coarse herbage which has been refused by sheep and cattle during summer, and some comprehending the entire herbage, free both from deterioration by depasturing and from diminution by cutting,—some including a greater or less proportion of carices and other rank and innutritious aquatics, and some consisting mainly of rich and tender grasses, similar to such as grow on good soils under a judicious system of artificial irrigation. But, in an aggregate view, this kind of hay, in all its varieties, is bad, and ought to be designated, not meadow-hay, but bog-hay or marsh-hay; and in almost all cases, it is too coarse for horses or even for sheep, and can be given only to cattle.

Another kind of hay consists of the dried produce of natural dry meadows. This also comprises many varieties; but, in a general view, consists principally of the rich, sweet, nutritious grasses which grow naturally upon porous or light alluviums. It is greatly superior in quality to the former; and, previous to the systematic cultivation of the artificial grasses, was regarded as the staple fodder of horses, and reserved for all the purposes of nice or special cattle-feeding; and, even in the present amplitude and diversity of provision for the farm-yard and the stable, it is still generally preferred to all other fodder for saddle-horses. It has always been abundant in England, and is usually and properly called by the English meadow-hay; but it has never been considerable in Scotland, and is always liable to be confounded by the Scotch under the common name of meadow-hay, with the produce of their marshes and boggy-hollows. "Yet," says Sir John Sinclair in the General Report of Scotland, "this is the hay with which the sheep pastured on the hills around Cheviot, in the counties of Roxburgh and Northumberland, are fed, when the ground is covered with snow. On the border sheep-farms, one or two low and fertile fields are reserved for producing this kind of hay. The stock is not allowed to enter them, after the first or second week of May; but before that time, they are either employed as an hospital, or stocked with ewes that have little milk or twin lambs." See the article Meadow.

A third and very important kind of hay consists of the dried produce of the artificial herbage-plants, principally tares, clovers, and ryegrass; and this is distributable into three great varieties, which may be designated tare-hay, clover-hay, and ryegrass-hay; yet it is capable of fully more diversity than either of the other kinds; and it owes all its diversity, in at least the species and number of its constituent plants, to the express intention and art of the cultivator, while they owe theirs, in a main degree, to the natural conditions of the soil and situation. But the normal variety of artificial hay,—or that which, in the present state of agriculture, may be regarded as hay *par excellence*, or as the standard by which all other varieties and both of the other kinds are judged—consists of equal quantities of clover and ryegrass,—not of equal quantities as merely sown, but of equal quantities as actually reaped,—for on good clay soils, the clover grows better than the ryegrass and eventually predominates, and on thin clay soils or on any kind of thin light soil incumbent upon clay, the clover may be extensively thrown out by spring frosts, so that the ryegrass shall greatly predominate. Prime normal hay is generally produced most readily, and also in the largest quantity, on deep mellow clayey loams; and when well made, as well as constitutionally excellent, it has a fragrant smell, a pleasant touch, and a light brownish-green colour.

The Various Produce of Hay.—Meadow-hay greatly varies in the quantity of produce, according to soil, season, situation, treatment, and herbage. Ordinary crops range from 12¾ cwt. to 21½ cwt. per acre; and when they yield the latter weight, they render meadow land in Highland districts more valuable than if it were either depastured or arated. But some crops are so light as to be far from remunerating; and a few are so exceedingly luxuriant as to weigh 44 cwt. or even 50 or 51 cwt. per acre. Some meadows, in even the seemingly unfavourable region of Caithness-shire, the country of "John-o'Groats," have produced 34½ cwt. per acre; one meadow there has occasionally produced a little upwards of 51 cwt. per acre; many meadows in Galloway have produced 34 cwt. per acre, and some 51 cwt; and several meadows in the parish of Mearns, about 8 miles south of Glasgow, have, for a long succession of years, produced from 34 to 48 cwt. per acre.

Hay of the artificial herbage plants is also very various in produce, according to soil, weather, culture, and the kinds and quality of the herbage. Crops on light gravelly soils, though generally of fine quality, are never heavy; and crops on good clay soils are generally heavy, and consist of strong and large plants. A poor crop may weigh about one ton per acre; a good crop, from 2 to 2½ tons; and a prime crop 3 tons. But these weights are to be understood of new-made hay from the tramp-ricks; for all hay, made of clover and ryegrass, loses considerable weight after stacking and through the winter,—and in the course of 6 or 7 months, is one-fourth or even one-third lighter than when taken from the field. "Hay that has stood six months in a large stack, will weigh, for every cubic yard, from 176 to 198 lbs., varying according to the size of the stack. But if it contains a large portion of clover, or is put in a small stack, it will not weigh quite so much. The weight of all sorts of hay, per cubic yard, in a great measure depends on the state of the weather when it is harvested, and the size of the stack."

The Marketage of Hay.—An act passed in the 36th year of George III. regulates the sale of hay in London, and within a distance of 30 miles round it; and this enjoins that all hay shall be sold by the load of 36 trusses,—that the truss of new hay, or of any hay of the season till the 4th of September, shall weigh 60 lbs.,—and that the truss after the 4th of September, or of any old hay, shall weigh 56 lbs. A load of new hay, therefore, weighs a ton; and a load of old hay weighs 18 cwt. But the real differences in the weight of hay at different seasons of the year and under different conditions of treatment, are far greater and more variable than the market-law indicates, and require to be well-known by a purchaser in order to his forming a correct opinion of the comparative height of prices at different seasons. Grass is usually computed to lose three-fourths of its weight on being made into hay, so that 400 lbs. when mown are reduced to 100 lbs. when stacked. About one-twentieth more is lost during the first month, and about the same quantity during the winter; so that the 400 lbs. when mown become 95 lbs. a month after stacking, and 90 lbs. at the beginning of spring. About one-ninth of what now remains is lost, at any time between the beginning of spring and the end of summer, in the operations of trussing, carrying to the market, and exposing to sale; so that the 400 lbs. when mown, or the 90 lbs. when taken from the stack, are reduced to 80 lbs. when delivered to the purchaser.

Hay, in most parts of Scotland, is sold by the stone tron, which is equal to 22 lbs. avoirdupois.—The market value of marsh hay is generally about one-third less than that of clover and ryegrass hay; and the market value of the produce of the latter, up to 1814, the date of the General Report of Scotland, varied from £2 10s. to £30 per Scotch acre, but, except in seasons of scarcity, rarely exceeded £12. The average price of good clover and ryegrass hay, in recent years, in the vicinity of large towns, and when the hay is quite new or sold from the tramp-rick, is about 8d. per stone of 22 lbs.; but it has ranged from 4d. to 1s. 4d.; and whenever the price is high, the crop is poor, and the hay is bad. Good crops often yield no higher a market value than about £7 7s. per acre; and prime crops, at the average price, yield only about £10. Hay, therefore,—as compared to many other kinds of produce, or even, in multitudes of instances, to the mere green herbage of grass-fields, used for soiling, or let out for piecemeal cutting—is a very inferiorly remunerating crop.

The Chemical Constitution of Hay.—Hay differs in constitution according to the particular plants of which it consists, the proportions in which these are mixed, the precise stage of growth or comparative immaturity at which they were cut, the manner in which the hay was made, and the degree of its exsiccation or the length of time which has elapsed since it was dried.

Marsh hay, comprising some carices and coarse grasses, necessarily contains far less nutritive matter than either fine meadow hay or ordinary clover and ryegrass hay; and hay of any kind necessarily contains nutritive matter, exactly to the amount in which that matter exists in the aggregate of its plants. A specimen of clover hay, grown upon a certain farm, for example, was found by analysis to contain 7·35 per cent. of mineral substances, 2·1 of nitrogen, 0·463 of phosphoric acid, 1·808 of lime, and 0·985 of bone earth; while a specimen of ordinary meadow hay, grown upon the same farm, and analysed by the same chemist, was found to contain 6·233 per cent. of mineral substance, 1·15 of nitrogen, 0·337 of phosphoric acid, 1·004 of lime, and 0·696 of bone earth; and if any two specimens of marsh hay and meadow hay, of marsh hay and clover hay, of coarse marsh hay and fine marsh hay, of coarse meadow hay and fine meadow hay, grown under similar conditions of situation and culture, were to be analysed, they would be found to exhibit as wide differences, or even considerably wider. Let any reader glance at the proportions of nutritive matter in the different species of pasture grasses, as stated in our notices of AGROSTIS, ALOPECURUS, FESTUCA, POA, PHLEUM, and the other genera of gramineous plants which occur in our pastures and meadows; and he will readily conjecture how very much the abundance or the paucity of even a single grass may affect the aggregate constitution of marsh or meadow hay.

Hay plants cut down while immature and quite succulent contain a comparatively large proportion of starch, sugar, and gum; and hay plants cut down in a ripening condition, have much of the starch, sugar, and gum which formerly belonged to them converted into woody fibre. Ryegrass, for example, passes with great rapidity from a state in which it has a maximum of water and sugar and a minimum of solid matter to a state in which it approaches a minimum of water and sugar, and a maximum of solid matter; and if a specimen of a crop of it be found between the 20th and 25th of June to consist of 81¼ per cent. of water and 18¾ per cent. of solid matter, a specimen of the same crop may be found only three weeks later to consist of 69 per cent. of water and 31 per cent. of solid matter. The longer the grasses stand, therefore, after they have attained their full height, the greater is their loss of sugar and other soluble matters, and the less digestible and less nutritious do they become; and even when they are cut down in a thoroughly succulent condition, and before they commence their transmutations toward ripening, they suffer much loss of sugar and starch, and undergo considerable lignefaction, from the continuation of organic changes, from the fall of rain, from the joint action of heat and moisture, and even from the mere play of air and light. A part of a crop made with all possible speed and promptitude into hay, is decidedly more nutritive than another part of the same crop made more slowly, and exposed for a longer time to the action of even the finest weather. Even the best conditioned, most opportunely cut, and most finely saved hay, too, may, from an over-retention of its succulency, or from the access of fogs and vapours to the stack, or from some other diffusion or accession of moisture, undergo such excessive fermentation in the stack as to pass from a sweet or saccharine condition to a sour or acetous condition; so that, after being two or three months stacked, it may not only become considerably lighter than new hay, but lose a material proportion of both its palatable and its nutrítious properties.

The amount of nutritive matter lost by the mere drying of hay is considerable in even the quickest and best methods of haymaking, but is very much greater in bad methods than in good. Very wide differences of opinion respecting this amount exist among farmers; and probably all the differences, even the widest, rest on facts, and may be accounted for by corresponding differences in the circumstances of haymaking. An extreme opinion supposes that one-half of all the nutritive matter is lost in the process of drying, or that one ton of green ryegrass or green clover contains as much nourishment as two tons made into hay; and a moderate opinion supposes—or rather rests on positive experiment by Dr. Thomson,—that every 100 or 120 lbs. of grass lose, in the process of haymaking, an amount of nourishment equal to 9 lbs. of barley or malt. "Some very valuable experiments, bearing directly on the subject of haymaking," say the editors of the Farmer's Almanac for 1847, "have, during the past year, been made by Dr. Thomson. The following is the analysis of three specimens of ryegrass, *Lolium perenne*, the grass employed. Specimen No. 1 was grown near Giessen, in Germany; No. 2, near Strasburg; No. 3, near Glasgow:—

	I.	II.	III.
Carbon . .	45·87	45·80	45 41
Hydrogen . .	5·76	5·00	5·93
Nitrogen . .	41·55	1·50	1·84
Oxygen . .		38·70	39·21
Ash . .	6·82	9·00	7·61

The constituents of ryegrass hay, the stem, and the seeds, are per cent. as follow:—

	Hay.	Stem.	Seeds.
Water . .	15·50	19·30	11·376
Organic matter .	79·52	75·72	82·548
Ash . .	4·98	4·98	6·070

The saline matters or ash of the stem and seeds of the ryegrass are as follow; and let the farmer carefully compare the two columns of this table, for he will find another argument against the practice of allowing the ryegrass to ripen its seeds before it is cut for hay, since the seed tends to remove from the soil a much larger portion (one-third more) of phosphoric acid than the stem;—of lime, two-thirds more.

	Stem.	Seed.
Silica	64·57	42·28
Phosphoric acid .	12·51	18·89
Sulphuric acid . .		3·12
Chlorine . . .		a trace
Carbonic acid . .		3·61
Magnesia . .	40·1	5·31
Lime	6·50	18·55
Peroxide of iron .	0·36	2·10
Potash . . .	8·03	4·80
Soda . . .	2·17	1·38."

Hay dried in the air at 212° Fahrenheit, according to an authority quoted by Liebig, loses 11·2 per cent. of water; and a specimen of hay thus dried, and burned with oxide of copper in a stream of oxygen, resolved itself into such quantities of water, carbonic acid, and incombustible matter as proved to consist of 45·87 per cent. of carbon, 5·76 of hydrogen, 41·55 of oxygen, and 6·82 of ashes. The ashes of a specimen of good meadow hay—consisting of a mixture of what Liebig calls silica plants, potash plants, and lime plants, and therefore seemingly much diversified in the species which it comprised—were found by analysis of Haidlen—after deducting 0·8 per cent. of loss—to consist of 60·1 per cent. of silica, 16·1 of phosphate of lime, 5·0 of phosphate of peroxide of iron, 2·7 of lime, 8·6 of magnesia, 1·2 of gypsum, 2·2 of sulphate of potash, 1·3 of chloride of potassium, and 2·0 of carbonate of soda.

The Salting of Hay.—A practice has long prevailed in some districts, and has, for some time, been generally recommended by many high agricultural authorities, of mixing salt with hay which has been damaged by rain, in the proportion of from 14 to 28 lbs. of salt to a load of hay; and when this practice is observed at the time of stacking, it is said, not only to prevent mouldiness and mowburning, but to render the damaged hay fully as palatable as the best-saved unsalted hay. The farmers of Derbyshire and of the North Riding of Yorkshire, have long salted their crops of rouen, and their wetted first crops of hay; and some farmers in the south of England have long salted all their hay in wet seasons, and have found it as nourishing to their stock, and as readily eaten by sheep, cattle, and horses, as fine unsalted hay of dry seasons. Even hay which has been caught by such heavy rains and freshets as to be flooded, may, by means of salting, be made thoroughly good and palatable. "If straw is mixed with the hay," says Loudon, "the heating of the stack is still further prevented, by the straw imbibing the moisture; and cattle will eat, not only such salted hay, but even the straw mixed with it, more eagerly than better hay not salted, and will also thrive as well upon it."

The converting of bad hay into better than the best readily suggested to even dull minds that the best might be made almost ambrosial; and the salting of damaged hay to make it fine, was therefore followed by the salting of undamaged hay to make it superfine. But the main use of salt is, not to transmute the properties of the hay—for this can be little more than fanciful—but to prevent it from suffering high and destructive fermentation; and as it instantly operates by its powerful affinity for moisture, it can serve this purpose only on moistened hay, and is almost certain to produce the opposite effect on hay which has been well-saved and is thoroughly dry. "Salting hay in the rick," says Mr. Winter, "is a most destructive practice. Nothing could be more ill-judged. Because animals are fond of salt, it was argued that, if hay were salted, they would always clear their rack of it, to the last morsel. Such is not the case; for much more is wasted than there would be if the pernicious custom were given up. Salt sprinkled on new-made hay in the stack, soon attracts moisture from the atmosphere, deliquesces, and musts the whole, however good it might previously have been. In this manner, I have seen many hundred tons of good hay greatly deteriorated. It is preferable to adopt any other method of administering salt, than that of brining the hay in the stack." See the article SALT.

But salt has, of late years, been used in Germany and East Prussia, for preserving cut grass, for a considerable time, in a succulent state, and so preventing the loss of nutritious matter which is occasioned by its transmutation into hay. "Pits are dug in the earth from 10 to 12 feet square, and as many deep; these are lined with wood, and puddled below and at the sides with clay. They may obviously be made of any other suitable dimensions, and may be lined with brick. Into this pit the green crop of grass, clover, or vetches, is put just as it is cut. Four or five cwts. are introduced at a time, sprinkled with salt, at the rate of one pound to each cwt.; and, if the weather, and consequently the crop, be dry, two or three quarts of water to each cwt. should be sprinkled over every successive layer. It is only when rain or a heavy dew has fallen before mowing that, in East Prussia, this watering is considered unnecessary. Much, however, must depend upon the succulency of the crop. Each layer of four or five cwts. is spread evenly over the bottom, is well trodden down by five or six men, and, especially, is rammed as close as possible at the sides with the aid of wooden rammers. Each layer is thus salted, watered if necessary, and trodden in succession, till the pit is perfectly full. Much depends upon the perfect treading of the grass for the exclusion of the air, and, therefore, for a pit of ten feet square, four cwts. are as much as ought to be put in for each layer. Between each layer may be strewed a few handfuls of straw, in order that, when emptying the pit afterwards for the daily consumption of the stock, the quantity taken out may be known without the necessity of a second weighing. When the pit is full, the topmost layer is well salted, the whole then covered with boards, or a well-fitting lid, and upon these a foot and a-half of earth, for the more perfect exclusion of the air. A pit ten feet square and as many deep will hold about five tons of fresh grass, and each pit should, if possible, be filled in not less than two days. When covered up, the grass speedily heats and ferments; and, after the lapse of about six days, when the fermentation has ceased, the whole has sunk to about one half of its original bulk. The lid must be examined during the fermentation, at least once a-day, and the earth, as it sinks, carefully replaced wherever crevices appear; for, if the air be allowed to gain admission, a putrefactive fermentation will come on, which will impart a disagreeable odour to the fodder, though it will not prevent it from being readily eaten by the stock. When the first fermentation has ceased, the lid may be removed, the pit again filled with fresh grass, trodden in, salted, and covered as before. A pit ten feet square, when perfectly full of this fermented grass, will contain nearly ten tons—equal to two or three tons of dry hay. The grass, when thus fermented, *has the appearance of having been boiled*, has a sharp acid taste, and is greedily eaten by the cattle. The pits should be kept covered for, at least, six weeks, after which they may be opened successively as they are required, and may be kept open till their contents are consumed by the cattle without suffering any injury from the contact of the atmospheric air. Of the feeding qualities of this salted fodder, one experimenter says that, by giving only twenty pounds a-day of it along with chopped straw, he kept his cows in condition during the whole winter. His green crop was vetches, and the twenty pounds of salted fodder were equal to, or would have made, less than four pounds of vetch hay. Another experimenter says that, on a daily allowance of twenty-eight pounds of his salted fodder, his cows gave a rich and well-tasted milk."

The Use of Hay as Food.—The feeding properties of hay, in the aggregate, in its principal constituent plants, and in its amount of nutritious matter as compared to other kinds of food, are discussed in the articles FEEDING OF ANIMALS, FATTENING OF ANIMALS, FOOD, and GRASSES; and the proper seasons and methods of using it are noticed in the articles CALENDAR and CHAFF-CUTTER, and in the articles on the principal animals fed with it, particularly the articles HORSE, CATTLE, COW and SHEEP.

Meadow hay, from rich alluvial soil, or even from such diluvial or mixed soils as produce a comparatively arid vegetation, is better for the wind and the general health of saddle and carriage horses than even the best hay made of the artificial herbage plants; and when old and prime, it is so much more satisfying that seven stones of it will go as far as eight stones of the latter; yet, in order to its maintaining this character, it must always be accompanied with a large proportion of oats or beans. Hay of artificial herbage, however, is really more nutritious in its composition, and therefore suits much better for the hard-working horses of the farm, whose comparative slowness of motion does not require any special attention to the effects upon their wind; though even this hay in their case, as well as meadow hay in the former case, requires to be accompanied with allowances of corn.

Hay about a twelvemonth old is the best for the horse,—not only because it has been freed from the needless moisture which it formerly retained, but because it has reached the maximum of the saccharine fermentation, and is in the fittest chemical condition for the horse's healthy assimilation. Hay much newer is preferred by the animal, but is not so nourishing to him, and frequently acts upon him as an aperient. But hay much older than a twelvemonth is hard, insipid, and difficult of digestion; and is less suitable than even somewhat fresh hay. Hay, too, which has been unduly heated and over-fermented in the stack, and has acquired the character popularly designated mowburnt, is exceedingly injurious to the horse, producing thirst, diabetes, emaciation, and the disease called hide-bound, and acting generally as a slow, but sure poison. —*Transactions of the Highland Society.—Sir John Sinclair's General Report of Scotland.—Boussingault's Rural Economy.—The Farmer's Almanac. —Johnson on Salt.—Knowledge Society's Farmer's Series.—Marshall's County Reports.—Loudon's Encyclopædia of Agriculture.—Liebig's Chemistry of Agriculture. — Youatt on the Horse. — Winter's Horse in Health and Disease.*

HAY-BARN. An erection for sheltering hay. It is usually constructed of timber; it may be open on one or two or even all sides; and it has usually, in the vicinity of London, a capacity for from 30 to 100 loads of hay, but may be of any convenient size from very small to very large. It greatly aids the speedy saving of hay in wet and windy seasons; it sometimes prevents a loss or deterioration in hay, to the value of from 10 to 20 shillings per load; and it is believed by many farmers to be economical in even the driest seasons. "Were landlords sufficiently alive to the value of the hay-barn," says Mr. J. Little, in his Prize Essay in the Highland Society's Transactions, "we should have one on every steading as certainly as the stable and cow-house. Possessed of a hay-barn, a farmer may almost be said to be independent of the weather, in the precarious season of hay-harvest. In a good year, he saves his crop without the loss of a handful, and at the smallest possible expense; in a bad one, he may have all, or the greater part of it snug in his barn, while his neighbour's is bleaching in coils, or rotting in summer-ricks. * * Hay, of the same degree of dryness, if put into a winter-rick, would certainly not keep, whilst in a hay-shed," or hay-barn, "it will do so perfectly. This arises probably from a much larger evaporating surface being exposed to the air, and the hay being put loosely into the shed, and in comparatively small quantities at a time; whilst a rick is generally put together at once, firmly trampled, and made as solid as possible, particularly above the eaves,—all conducing to bring on and to encourage fermentation." Some curious varieties of skeleton hay-barns are in use. See the article BARN.

HAY-BINDING MACHINE. An apparatus for weighing and binding trusses of hay or straw. It comprises all the implements requisite for cutting, weighing, and binding; it can all be promptly packed up, for removal from place to place, in the form of a wheel-barrow,—and can as promptly be taken to pieces and set up in its own proper character; and it allows hay or straw to be quickly and conveniently heaped upon a bed or horizontal frame,—weighed, by means of a connected standard and steel-yard, into the exact quantity of a truss,—and bound and packed on the spot with hay-bands. This machine was invented by Beckway; and may be very serviceable to occasional retailers of hay or straw.

HAY-BOTE. A liberty enjoyed by a tenant, for life or for a term of years, of cutting down bushes and copsewood for the repairing of gates, fences, and the small wood-works of the farmery; also, the liberty of cutting wood, for the making and repairing of the rakes and forks used in haymaking.

HAY-COCKS. See HAYMAKING.

HAY-CUTTER. See CHAFF-CUTTER and STRAW-CUTTER.

HAY-FARMER. A farmer who is chiefly occupied in growing, making, and selling meadow hay for the use of cow-feeders, and of saddle and carriage horse-keepers. Hay-farmers occur principally in the near vicinity of London.

HAY-FRAME. See CART.

HAY-HOUSE. A division or apartment of the buildings of a farmery, adjacent to the work-horse stable, and near the stack-yard, for containing a store of hay for immediate and current consumption by the work-horses. See the article FARM-BUILDINGS.

HAY-KNIFE. An edged implement for cutting supplies of hay, from time to time, out of the hay-stack. One variety of it is shaped somewhat like the dung-spade, and is used by a person in a standing posture, and cuts either to the one side or to the other, and admits of a free use of power so as to make a deep incision; and another and more common variety of it has a long, broad, one-edged blade and a very briefly-attached cross-handle—the blade inclines a few degrees from the line of right angles with the handle—and it is used by a person on his knees, and with his face to the body of the stack, and admits of but a limited or considerably hampered play of strength.

HAYLOCKIA. A genus of ornamental, bulbous-rooted plants, of the amaryllis order. The dwarf species, *H. pusilla*, was introduced nearly 20 years ago from South America; and has a height of 5 or 6 inches, and carries beautifully striped flowers.

HAYMAKING. The process of converting green succulent herbage into hay. The mere cutting down of the herbage is not proper to haymaking, and will be noticed in the article MOWING.

The Principles of Haymaking.—Haymaking essentially consists in expelling moisture from the plants; it ought to be so conducted as to expel little or nothing else than water, and to retain as much of even this as will comport with the perfect conservation of the hay; and it must address itself principally to the prevention of fermentation from the action of the atmospheric heat upon the intrinsic moisture and gluten of the plants,—to the averting of saturation, dilution, and fermentation from the occurrence of rain,—to the most dexterous use of wind and sunshine for the drying of the plants in the shortest possible space of time,—and to systematic, prompt, and safe storage of the dried crop in such barns, sheds, or stacks as shall maintain it in a state of the highest preservation.

The preventing of fermentation is essential on account of the great amount of deteriorating change which even a small degree of speedy fermentation makes upon the palatableness and especially upon the nutritive value of the plants; and it requires much care, much good management, and the freest possible aeration of every portion of the crop, on account of the very apt condition of the external heat and the internal juices to set up fermentation.—The averting of bad effects from rain is necessary on account of the prolonged exposure to the atmospheric agencies, the deleterious action of the rain-water upon both the fibre and the juices of the cut plants, the waste of labour and capital in the multiplied processes of drying, and, above all, the concurrence of the rain-water with the heat and the juices to set up such a violent fermentation as shall actually decompose and "rot" the plants.—The drying of the crop in the shortest possible time, or by the methods of frequent tossing and turning and of the most abundant aeration which tend most rapidly to expel the intrinsic moisture, is necessary, as was explained in the article on HAY, to prevent the chemical transmutation of a large amount of the starch, gum, and sugar of the plants into woody fibre. —The cutting down of the crop, too, at a moment between the completion of its stature and the commencement of any tendency to seed, is requisite for the same reason as the speedy drying of the crop, and in a far more urgent degree; for whenever gramineous and leguminous plants commence the process of seeding, they begin to lignefy their stems and to concentrate their chief nutrient principles in the substance of their seeds; so that a crop of these plants which is intended to feed animals with its seeds must be allowed to stand to full maturity, a crop which is intended to feed with its stems and leaves ought to be cut down before the tendency to seed has begun, and only a crop which ignorance and folly consign to yield the smallest possible amount of food may be cut down in the transition between relinquishing the nutritive principles of the herbage and assuming the nutritive principles of the seed.

The Scotch Methods of Haymaking.—The farmers of the lowland districts of Scotland, though equal or superior to the farmers of most parts of England in almost every other department of husbandry, are exceedingly deficient in the art of haymaking. The great body of them continue, in spite of all modern improvement, to make hay in a wasteful and almost barbarous manner; and a few have, of late years, made good hay chiefly by imitating the practices which have long and generally prevailed throughout the greater part of England. The Scotch usually allow the ryegrass and clover plants to stand till some mature seed can actually be obtained from the ryegrass; and not a few of them, by way of testing the supposed fitness of the crop for the scythe, actually sweep their hat along the top of a yard or two of it to see whether the hat will catch any ryegrass seeds, and judge that the crop shall not be cut till some seeds can be caught. They also, after the crop is cut, purposely subject it to such a slow winnowing process as shall harden the ryegrass seeds, and fit them to be used for next year's sowing; and they thus sacrifice a large proportion of the nutritive matters of the ryegrass plants, and allow an enormous amount of the starch and gum and sugar of the clover to be transmuted into woody fibre, for the sake of the pitiful and drivelling purpose of obtaining sowable ryegrass seeds,—an object which might readily be gained, without any sacrifice whatever, and with less trouble and better effect, simply by growing a little ryegrass by itself with the express design of its seeding. In the case of meadow hay, many of them do far worse, and without any excuse,—allowing the crop to stand uncut till August, when the stems of the plants have lost most of their natural juices, and their seeds are nearly ripe; and in the case of both this hay and the ryegrass and clover hay, they allow the crop to lie for some days in the swath till a considerable portion of its moisture passes off by slow evaporation,—they next shake it out and turn it over, and allow it to lie again for some days undisturbed till it is thought sufficiently dry for putting into large cocks,—and even after all this, they, in many instances, permit it to stand during two or three months in the cocks before stacking it or removing it to the farm-yard. Some seem to proceed on the absurd assumption that all fermentation to which it may be subjected ought to be over before it is stacked; but the greater number probably act without reflection or inquiry, simply making their hay, they know not why, as their fathers made it before them. Yet such Scotch farmers as carry the caution and sagacity and calculating spirit of their general husbandry into the economics of their haymaking, though they have never carried these into the practices of it, are well aware of their hay being a deplorably uncompensating crop, and have a hearty wish that it could be entirely superseded by something better; and hence not a few of them know their haymaking practices to be wrong, and yet are careless to rectify them,—but as the season for the singling of turnips and the proper season for haymaking occur nearly at the same moment, they give prompt and thorough attention to the turnips and allow the hay-plants for a time to take care of themselves. How unworthy is this of Scotland! How similar to the blundering and improvidence of the cabin-farming of the worst parts of Ireland! A very slight degree of management would prevent haymaking and the singling of turnips from interfering with each other; and any man who produces hay at all ought to produce it well. Good haymaking is not only as cheap as bad haymaking, but cheaper; and all the loss which accrues from making hay in any but the best manner, is due simply to bullheadedness and absurdity. What a reproach upon the otherwise intelligent and peerless farmers of Scotland is the following simple statistical sentence from the pen of their own national agricultural chemist, Professor Johnston: "In the dales of Yorkshire, cattle can be fattened upon hay alone, which is said to be rarely the case to the north of the Tweed!"

The English Methods of Haymaking.—Middlesex, though excelled by other districts in the dexterity and finish of mowing, may probably be regarded as the model-district of England and of the world in the proper art of haymaking; and though the practices pursued in it would require to be modified in many other places in adaptation to differences of climate and of other circumstances, they afford an excellent practical guide for either testing or improving the practices of other districts. We shall therefore quote a succinct account of them, which was first given in Middleton's Agricultural Survey of Middlesex, and republished, with slight verbal alterations, in Baxter's Library of Agricultural Knowledge; and, "in order that the subject may be clearly understood," says the writer, "it will be necessary to relate the particular operations of each day, during the whole process, from the moment in which the mower first applies his scythe, to that in which the hay is secured either in the barn or in the stack."

"First Day.—All the grass mown before nine o'clock in the morning is tedded," or tossed and turned with the hay-forks, "in which great care is taken thoroughly to loosen every lump, and to strew it evenly over all the ground. By this regular method of tedding grass for hay, the hay will be of a more valuable quality, heats more equally in the stack, consequently, is not so liable to damage or fire; will be of greater quantity when cut into trusses, and will sell at a greater price; for, when the grass is suffered to lie a day or two before it is tedded out of the swath, the upper surface is dried by the sun and winds, and the interior part is not dried, but withered, so that the herbs lose much, both as to quality and quantity. The next operation consists in turning it with the same degree of care and attention; and if, from the number of hands, they are able to turn the whole again, they do so, or at least as much of it as they can, till twelve or one o'clock, at which time they dine. The first thing to be done after dinner, is to rake it into what are called single windrows; that is, they all rake it in such a manner as that each person makes a row, which rows are three or four feet apart. The last operation of this day is to put it into grass-cocks.

"Second Day.—The business of this day commences with tedding all the grass that was mown the first day after nine o'clock, and all that was mown this day before nine o'clock. Next, the grass-cocks are to be well shaken out into staddles, or separate plats, of five or six yards in diameter. If the crop should be so thin and light, as to leave the spaces between these staddles rather large, such spaces must be immediately raked clean, and the rakings mixed with the other hay, in order to its all drying of an uniform odour. The next business is to turn the staddles, and after that, to turn the grass that was tedded in the first part of the morning, once or twice, in the manner described for the first day. This should all be done before twelve or one o'clock, so that the whole may lie to dry while the work-people are at dinner. After dinner, the first thing to be done is to rake the staddles into double windrows—in doing which, every two persons rake the hay in opposite directions, or towards each other, and by that means form a row between them of double the size of a single windrow. Each of these double windrows is about six or eight feet distant from the other. The next operation is to rake the grass into single windrows; then the double windrows are put into bastard-cocks; and lastly, the single windrows are put into grass-cocks; this completes the work of the day.

"Third Day.—The grass mown, and not spread on the second day, and also, that mown in the early part of this day, is first to be tedded, and then the grass-cocks are to be spread into staddles as before, and the bastard-cocks into staddles of less extent. These lesser staddles, though last spread, are first turned, then those which were in grass cocks, and next, the grass is turned once or twice before twelve or one o'clock, when the people go to dinner as usual. If the weather has proved sunny and fine, the hay which was last night in bastard-cocks, will this afternoon be in a proper state to be carried. It seldom happens in dry weather, but that it may be carried in the third day; but if the weather should, on the contrary, have been cool and cloudy, no part of it probably will be fit to carry. In that case, the first thing set about after dinner, is to rake that which was in grass-cocks last night, into double windrows. After this, the hay which was last night in bastard-cocks is made up into full-sized cocks, and care taken to rake the hay up clean, and also to put the rakings upon the top of each cock. Next, the double windrows are put into bastard-cocks and the single windrow into grass-cocks, as on the preceding days.

"Fourth Day.—On this day, the great cocks just mentioned are usually carried before dinner. The other operations of the day are such, and in the order as before described, and are continued daily until the hay harvest is completed. In the course of haymaking, the grass should, as much as possible, be protected, both day and night, against rain and dew, by cocking. Care should also be taken to proportion the number of haymakers to that of the mowers, so that there may not be more grass in hand at any time than can be managed according to the described process. This proportion is about 20 haymakers (of which number 12 may be women), to 4 mowers. The latter are sometimes taken half-a-day to assist the former; but in hot, windy, or very drying weather, a greater proportion of haymakers will be required than when the weather is cloudy and cool. It is particularly necessary to guard against spreading more than the number of hands can get into cock the same day, or before rain. In showery and uncertain weather, the grass may be suffered to lie three or four and even five days in swath. But before it has lain long enough for the under side of the swath to become yellow—which, if suffered to lie too long, would be the case—particular care should be taken to turn the swaths with the heads of the rakes. In this state, it will cure so much in about two days, as only to require being tedded a few hours, when the weather is fine, previous to its being put together and carried. In this manner, hay may be made and stacked at a small expense, and of a good colour; but the tops and bottoms of the grass are insufficiently separated by it."

Mr. Towers narrates the case of a distinguished haymaker who rose from very low circumstances to great affluence,—who was originally a dyer, but purchased much land in Somersetshire, and farmed a considerable portion of it,—who made hay nearly forty years, and scarcely ever failed, in one instance, to carry it in good condition,—and who stated the secret of his success in these remarkable terms,—"In the month of June, earlier or later, there are three or more days wherein the wind blows from the north-east, and that period is always dry; when that wind first occurs, I seize the moment, call in the hands from the factory, cut the grass, and carry the crop before the wind veers to the south." Now, says Mr.

Towers, "I mention this circumstance, not by any means to induce every one to consider June as the hay month, but to inspire caution and watchfulness. There, perhaps, is to be traced everywhere a season, a period of a few days at least, when certain indications give assurance of settled weather. Now, if these be improved, they, 'like the tide in the affairs of men, which, taken at the flood, leads on to fortune,' will almost infallibly suffice to secure the hay! There must, however, be no half measures, no daudling at the work; all must be bustle, energy, and decision; and, be it never forgotten, that a ton of good hay is worth three tons of half-decayed rubbish, void of odour or flavour, and worthless in the stable or cow-stall."

The English method of haymaking has, for a number of years past, been adopted and very successfully practised in some of the border districts of Scotland,—hilly in surface, moist, cold, and very changeable in climate, and widely different from Middlesex in many of the latter's amenities of situation; and an account of it as practised in one of these,—the district around Langholm,—appears in a Prize Essay in the 14th volume of the Highland Society's Transactions, and shows that very little modification of the method has been found necessary. "The practice recommended," says that account, "is for the mowers to begin in the morning, and the haymakers to commence their duties at 11 A. M. of the first day, and, before going to dinner, to ted all the grass cut that morning; if the crop be thick, shake out carefully by hand. At 3 P. M. turn over to the sun or wind, whichever is the more drying; in the evening, put in footcocks. Second day,—as soon as the dew is off, shake out footcocks, then grass cut yesterday afternoon, and this forenoon; what was shaken out of footcocks should be turned before dinner, and again about 3 P. M.; and should the weather be favourable, dry lea-grass may be carried in the evening. The swathes cut yesterday afternoon and this forenoon, should be shaken out and turned as often as necessary, and put into cocks in the evening. A heavier crop will seldom, the weather being the same, require more than 24 hours longer, unless the soil be wet or the field sheltered from the sun and drying winds. In this case, repeat the process of shaking out, turning as often as requisite, and putting into cocks or coils in the evening, making them bigger as the hay gets drier. If the soil be dry, and the weather have a decidedly settled appearance, some trouble may be saved by putting into windrows in place of coils; the latter, hower, is generally preferred in this uncertain climate."

The Implements of Haymaking. — The implements used in haymaking by manual labour, or in the methods we have hitherto noticed, are the scythe for cutting, the fork for tedding, and the rake for gathering; and these are noticed in the articles SCYTHE, FORK, and HAY-RAKE. But two other and far larger and more complicated implements, adapted to horse-draught, are now used on some extensive hay-farms, and occasion much economy in haymaking, and considerable modification of the mere manual methods of it; and these implements perform the work respectively of tedding and gathering, and will be noticed in the articles HAY-TEDDING MACHINE and HAY-RAKE.

The hay-tedding machine very effectively takes up and tosses and scatters the mown plants, dispersing them or laying them down again with perfect regularity; and it works best and performs its office with admirable power and despatch, when made to pass across the swathes. It has been pronounced, on all hands, to be an excellent tedder of meadow hay; yet has been demurred against, by Scotch farmers, for its rough treatment of artificial hay, in shaking out the seeds of the ryegrass. But, as we have already shown, ryegrass in the proper condition for hay has no seeds to shake out; so that when Scotch farmers learn to mow their ryegrass at the economical time, they will like the action of the machine just as well upon it as upon the natural grasses. The tedding machine does its work in the morning; the crop tossed and scattered by it lies fully exposed to the sun and the wind throughout the forenoon; and the horse-rake gathers the scattered crop into windrows in the afternoon. But the subsequent parts of the process, consisting in the formation of the cocks, and in whatever may be rendered necessary by the fall of rain, must be performed by mere manual labour.

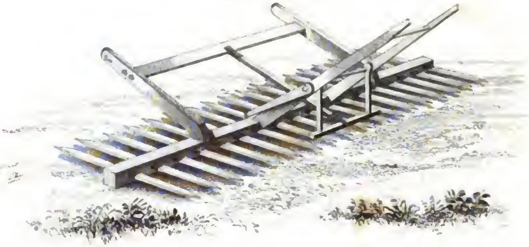
The Storing of Hay.—The great advantages of hay-barns or hay-sheds, in enabling the farmer to remove the hay from the field with all possible speed, in offering facilities for protecting it in unsettled weather, and in permitting it to be safely stored in a less exsiccated state than would be suitable for stacks, have been sufficiently adverted to in the short article HAY-BARN. Every haymaking farmer who possesses this convenience may—and in precarious weather ought to—remove his hay from the field to the hay-barn whenever it becomes dry enough to be formed into a summer-rick. The best way of stowing is not to make it into separate mows, but to spread it athwart the whole area of the barn, and to deposit it in light, regular, and evenly shakings. Almost any quantity of meadow hay may safely be stored with any degree of speed in a large hay-barn; but not more than from 15 to 20 cart-loads of clover and ryegrass hay ought to be stored in one day,—and the whole of this should be deposited deliberately, in a series of the thinnest dispersions, or in the lightest manner possible. The mass of the hay, partly from its mere gravity and partly from the effect of the saccharine fermentation, will, for two or three weeks, subside considerably; and it ought, from time to time, to receive additional layers on the surface till it shall have completely settled. But as a finishing to it, the topmost layer, to the thickness of 12 or 18 inches, and immediately subjacent to the roof, ought to consist of straw, ferns, rushes, or coarse grass; and this coat, of worthless material and easily removable, will prevent the upper strata of the hay from becoming too much dried, or from contracting rot and mouldiness.

The storing of hay in stacks differs considerably from the stacking of corn, and requires to be conducted with care and steadiness. The site of the stack ought to be perfectly dry; or if it must be selected in some spot which may be suspected of liability to become somewhat damp in winter, a trench of 6 or 8 inches in depth ought to be dug around it, and quite close to it, to carry off any water which might possibly accumulate. The whole of the site, also, must be formed, to the height of about a foot above the circumjacent surface, with some material which shall prevent all connexion between the surrounding and subjacent ground and the hay's affinity for moisture; and this material may be either any kind of hay-stand or a series of pieces of timber, with a filling-up of brushwood or faggots in the interstices, or may consist of a circle of large stones round the circumference, and a firm bed of stone shivers or large gravel throughout the interior. See the article HAY-STAND. The stack may be either a circle, a square, a parallelogram, or any other form, but is usually most convenient in some variety of the rectangle; and it ought, in every instance, to have only a moderate width, in order that it may not incur any unnecessary risk of becoming heated. Bosses, chimneys, pipes, and other contrivances for ventilation have sometimes, as in corn-stacks, been used to prevent heating; but they assist the hay to attract moisture, and probably do more harm to it than good.

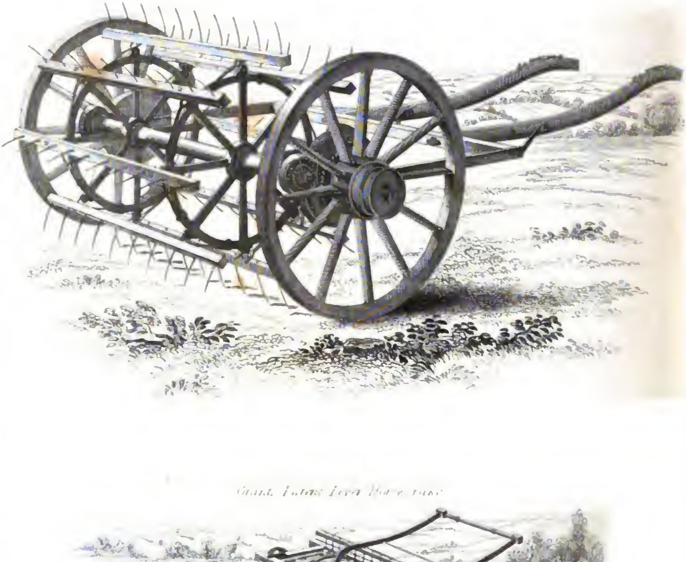
Throughout the process of building, the middle of the stack ought always to be maintained at a considerably greater height than the circumference,—the depositions of hay ought to be made with such a shaking action as will tear all lumps asunder, and render the whole texture open,—layer after layer along the sides and the ends ought to be thoroughly bound in by the proper adjustment of the hay,—and the whole exterior facing ought to be kept neat, tight, and in perfectly regular form by the pulling out of projecting wisps and straws. "There are no haystacks more neatly formed or better secured," says Middleton, "than those of Middlesex. At every vacant time, while the stack is carrying up, the men are employed in pulling it with their hands into proper shape; and about a week after it is finished, the whole of it is properly thatched, and then secured from receiving any damage from the wind by means of straw-ropes extending along the eaves up to the ends and near the ridge. The ends of the thatch are then cut evenly below the eaves of the stack, just of sufficient length for the rain-water to drip quite clear of the hay." In Berkshire and other districts, the hay nearly ready for stacking is spread out in the morning, after the dew has passed off, into breadths or staddles; the waggons are drawn into the field, and arranged in proper position; the hay, after being finally dried in the wind or the sunshine, is raked from the breadths into ridges, and thence forked into the waggons; and the ground is immediately so well raked by the female-workers as to effect the careful gleaning of the crop, and the complete clearance of the field. In Somersetshire and other western counties, the finishing operation is to cut the lower part of the stack, to the height of two feet above the base, with a hay-knife, so as to make all this part slope toward the base at an acute angle.

A progressive and comparatively slow course of storing hay in stacks, is practised in the southern parts of England with the aid of a rick-cloth, almost as facilely and safely as the progressive course of storing in hay-barns. The slowness of daily stacking from handcocks, or from any condition of fitness for summer-ricks, renders the quality of the whole stack uniform, promotes the speediest possible saving of the crop, and averts the risks and loss from exposure to the weather which are occasioned by keeping the earliest-cut in the field till the latest-cut is dry. The rick-cloth is suspended on poles, and hangs over the stack like a kind of pavilion, and affords complete protection both from rain and from the injurious play of sunshine. Rick-cloths of all desirable forms and sizes are made by manufacturers in London; and possess at once neatness, portability, and nice adaptation. But an old contrivance, practised in Kent, and described by Marshall, is quite as efficient and nearly as facile as the regular rick-cloth, and is always much cheaper, and sometimes more easily obtained; and it consists principally of an old or half-worn square sail-cloth, three long light poles, and two common cart-wheels. "Two tall poles — ufers, fir-balks — are stopped firmly in two cart-wheels,—which are laid flat upon the ground at each end of the stack, and loaded with stones to increase their firmness. Another pole, of the same kind, and somewhat longer than the stack, is furnished at each end with an iron ring or hoop, large enough to admit the upright poles, and to pass freely upon them. Near the head of each of the standards is a pulley, over which a rope is passed, from the ring or end of the horizontal pole, by which it is easily raised or lowered to suit the given height of the stack. Even when a rick is begun with only two loads of hay, these two loads are as securely guarded from rain, until more can be got ready, as if they were housed; for a cloth being thrown over the horizontal pole, and its lower margins loaded with weights, a complete roof is formed, and exactly fitted to the stack, whether it be high or low,

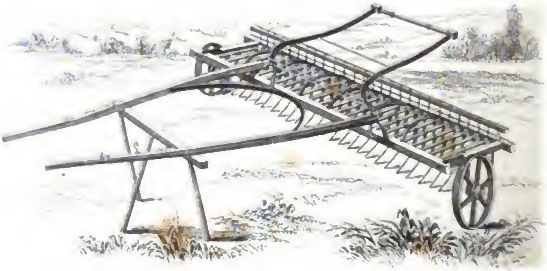
American Hay rake



Salmon's Hay making Machine



Grant's Patent Lever Horse rake



A. Fullarton & Co. London & Edinburgh

wide or narrow,—the eaves being always adjusted to the wall-plate or upper part of the stem of the stack, thus effectually shooting off rain, while the internal moisture or steam arising from the fermentation of the hay escapes freely at either end, as the wind may happen to blow. What renders this ingenious contrivance the more valuable, is its being readily put up or taken away. The poles, being light, are easily moved from stack to stack, or laid up for another season; and the wheels are as readily removed, or returned to their axles." But a novice in the use of the rick-cloth must guard against the error of supposing that it will serve its purpose if not mounted in a roof-formed fashion upon poles, or if merely spread in a loose manner over the stack. "A sail-cloth thrown over and immediately upon the hay of a stack in full heat," remarks Marshall, "is liable to do more injury by increasing the heat, and at the same time checking the ascent of the steam, than service in shooting off rain-water. Besides, when the stack is broad, the cloth, thus spread over it, is liable to bag in particular parts, and thereby to form receptacles and pools of water, which, unless the cloth be very tight, find their way in currents into the body of the stack." Nor will merely two upright poles and a fixed transverse one serve the purpose of properly suspending the cloth; for there must be stays to retain the upright poles in their strictly perpendicular position, and tackle to lower or heighten the horizontal pole, in accommodation to the successive heights of the stack.

The Scotch practice of stacking a crop of hay in one day, requires the final accumulations in the field to be sufficiently large and compact to offer considerable resistance to the weather. These accumulations, in common Scotch practice, contain each from 100 to 150 stones of hay, and bear the name of tramped pikes; they are formed by two persons forking, building, and tramping; and they are usually disposed in a row along the end of the field. Unless the hay stand for some time in these large ricks, it cannot, without risk of heating, be stacked in one day. In building the stack, two men deposit the hay in successive thick layers as high as their breast, a series of women trample down each layer or "dace," and several men fork up the hay first from the ground, and next from short ladders, or successively from the ground and from the platform of a simple and temporary scaffolding. The breadth of the stack is slowly increased to the eaves, at the height of about 12 feet from the ground; and is then gradually diminished to the ridging, at the height of about 6 feet above the level of the eaves. The stack is left several days to subside and to throw off any amount of heat which it may develop; it is from time to time propped, if necessary, at any point of very special subsidence; and after having fully subsided and cooled, it is carefully thatched and roped.—*Transactions of the Highland Society.—Quarterly Journal of Agriculture.—Essays on Agriculture.—Sir John Sinclair's General Report of Scotland.—Marshall's Rural Economy of the Southern Counties.—Sproule's Treatise on Agriculture.—British Husbandry.—Stephens' Book of the Farm.*

HAY-RACK. An open or railed wooden frame, to contain hay, straw, or other fodder, for the immediate use of horses, cattle, or sheep. The hay-rack of the stable is a necessary and prominent part of the furnishing of each stall; and is usually adjusted in a high position, so as to oblige the horse to pull the fodder down, but may, with considerable economy to both the animal and the fodder, and without any concurrent disadvantage, be adjusted in a low position. See the article STABLE. Moveable and covered or roofed hay-racks are used for affording hay to sheep in the field, either during a deficiency of grass, or as an accompaniment of feeding-off turnips. See the article SHEEP.

HAY-RAKE. An implement for gathering and accumulating hay, in the processes of haymaking.

The hand hay-rake usually consists of a shaft of any convenient length, a head or transverse bar of from 24 to 27 inches in length and about 1 or 1¼ inch in thickness, and 12 or 13 wooden teeth of about 3 or 3½ inches in length. But it greatly varies in the kinds of wood of which it is made, in the mode in which the attachment of the head to the shaft is fortified, in the manner in which the teeth are fixed into the head, and in both the relative and the absolute dimensions of its several parts. The head requires to consist of some hard wood; while the teeth may advantageously consist of either ash or oak; and the latter must never be so long as to pull up the roots of the grasses in raking, and are sometimes screwed into the head, and made fast with nuts to prevent them from dropping out after a long drought. Willow is a favourite material in England on account of its lightness and free play in raking.

The American hay-rake is a one-horse implement, of curious yet simple construction, and of very considerable efficiency in the economising of labour. It works either along the ridges or across them; it can carry between 10 and 12 stones of hay; and, by means of a simple revolution, it deposits its accumulated load in rows or on any particular spot required, without occasioning the horse to be stopped. This implement is represented in *Fig.* 1, *Plate XXVII.* "The head AB is 9 feet 8 inches in length, and 4 inches square, into which are inserted 18 teeth, *a*, *b*. Each tooth is 3 feet 11 inches in length from *a* to *b*, that is, 1 foot 9½ inches on each side, and 4 inches for the breadth of the head AB, through which they pass; these teeth are 1 5/16 inch broad by 1 3/16 inch thick or deep. About 5 inches next the point *a*, they are tapered on the under side, and the same length at the point *b* on the upper side, to prevent in some measure the teeth from having too great a tendency to go into the ground. The frame to which the draught is attached, consists of the circular beams C and D, with the connecting stretcher E. The beams C and D, at the end next the head AB, are each cut into a semicircle, and made to run round the journal of the head which is wrought to 3 inches in diameter, by 2 inches in length, and bound by an iron strap upon these beams forming the outside. At C and D are straps to which the horse is attached by traces or ropes, in a similar way to that in which it is attached to the plough, but without swingle-trees. The stretcher E, which attaches the beams C and D, is 5 feet 4½ inches in length, measured over the beams. The part by which the instrument is guided, consists of the handles F and G, forming a frame 4 feet 7 inches long, by 2 feet 2 inches broad. These handles are circled and strapped for the journal of the head, in the same manner as the beams C and D. A little from the end of the handles at F and G, is a round connecting stretcher; and at *d*, 2 feet from the centre of the head, is another round stretcher. From this latter stretcher is appended the frame *e*, forming a parallel motion. The two standards of this frame are each 12½ inches long, or, from the outside of its head at *e* to the centre of the stretcher, 10 inches. There is a connecting rod *c*, 3 feet 8 inches long from centre to centre, which is circled and strapped round journals at E, and *e* the round stretcher at *d* is continued on the outside of F and G, so as to accept of a rod or catch on the outside of these handles, as seen at *d* 2 feet 10 inches long, or 2 feet 2½ inches to the centre of the connecting stretcher at *d;* and upon the head AB the other end of each of these two rods or catches rests upon a kneed strap, a similar strap being also on the reverse side of the head. Now, when the frame CDE, to which the draught is attached, is in its proper position, by depressing the handles FG, the parallel motion at *e* will be pressed against the hind teeth, and thus the fore ones can be raised up, in order to surmount any inequality of ground. And when it is wanted to depress the fore-teeth, the handles FG are to be raised, by which the rod or catch at *d* and its opposite side act upon the kneed straps on the head. When the rake has collected as much hay or corn as it can conveniently carry, it is emptied in the following manner. By raising the handles FG to a certain extent, the fore-teeth are depressed in the manner above described, and (the point E remaining the same) the rod *c* pushes the under side of the parallel motion without the hind-teeth. In this manner, as the beams and handles are all placed between the teeth, so as not to come in any way in contact with them, the fore-teeth take the ground, and cause the whole teeth with the head to revolve, and deposit the hay or corn which the instrument was carrying at the time. By this revolution of the teeth and head, the instrument will again be in its proper position for working, all the difference being merely that the under side of the head will now have exchanged places with the upper side, and the fore-teeth will now have exchanged places with the hind-teeth."—[Transactions of the Highland Society.] This implement has sometimes been made of smaller size than now described; and it promised, at one time, to come into general use, but has already lost much of its early reputation. It ought, in order to complete efficiency, to be mounted on a pair of low wheels, and so adjusted as to present the points of the teeth downward, instead of forward; and probably for want of this simple improvement, it is less esteemed, in aggregate practice, than horse-rakes of much inferior construction.

The Norfolk horse-rake is one of the simplest and clumsiest of the many varieties of wheeled horse-rakes, and may be generally described as a strong rake-head attached by means of deeply-sloping bars to the rear of a one-horse yoke with axle and low wheels; yet it can easily rake from 20 to 30 acres in a day; and it deposits its accumulations in regular rows along the field, simply by means of a momentary lifting up of the rake-head, and without occasioning the horse to be stopped.—Wedlake's horse-rake is a much more finished implement than the preceding, and was officially approved at the Royal Agricultural Society's Meeting, a few years ago, at Cambridge. Its head is long, and has very numerous tines, each tapering to a point, and all slightly curved forward; it is so attached to the raised axle of the machine, by two peculiarly formed bars, as to be counterbalanced on the opposite side by two heavy, projectingly-situated balls; and, from time to time, as occasion requires, it is neatly and promptly lifted up by means of a pair of handles, so as instantly to drop its accumulations. —The hay and stubble horse-rake, sometimes called for sake of distinction the East-Lothian stubble-rake, comprises many varieties, and is now perhaps the most common implement of its class; and, as its name implies, it is used, not only in haymaking, but for the cleaning of corn-stubbles. Its frame is mounted on two low wheels; a number of bars, each bearing one iron tooth, are jointed horizontally to the frame, and at the same time connected by short vertical chains to a cross-head which commands the whole line of teeth, and is furnished with a pair of handles, for jerking up the line of teeth, and causing them suddenly to let go their accumulations. One variety of this implement, as improved by John Sayer of Norfolk, has teeth of such a form as to be less injurious to the grasses than those of the common horse stubble-rake, and also possesses superior facilities of working. —Grant's patent horse-rake obtained the prize at the Royal Agricultural Society's Meeting, a few years ago, at Liverpool; and is exceedingly neat and compact, and by far the finest variety of the horse stubble-rake, but much too expensive to be likely to come into general use. It is represented in *Plate XXVII.* "Its advantages consist in the adaptation of a compound lever, by which the whole row of tines may be instantly raised, and as quickly allowed to resume their position; while the form of the teeth, being such as to describe part of a circle, the centre of which is the axis of the separate levers to which they are attached, each portion of the curve is successively brought into a vertical position, thus rapidly disengaging the teeth from the material collected, so that, without stopping the horse, the process of collecting is resumed, leaving no interval beyond what is requisite for the deposit of the hay, corn, or stubble previously collected." [Ransome's Implements of Agriculture.] Other implements used either in the immediate process of raking, or in processes akin to it and connected with it, will be noticed in the articles Rake, and Hay-Tedding Machine.

HAY-RICK. See Haymaking.

HAY-STACK. See Haymaking.

HAY-STAND. A low platform, serving as the basis of a hay-stack or of a large hay-rick. It may be formed similarly to any of the approved rick-stands for corn; but does not require to be either so nicely or so expensively made; and it may, for all purposes of real utility, consist merely of a coarse, strong, simple frame of wood, resting on proper bearers.

HAY-SWEEP. Any implement or contrivance for dragging together scattered hay to stack, rick, or cart. It may be either a rake, or a rope, or two slightly curved bars of wood with a series of transverse bars, jointly forming a kind of rail, and dragged forward by ropes attached to the four corners.

HAY-TEA. Either a decoction or an infusion of hay. A sufficient quantity of prime hay is either boiled in water, or macerated with boiling water, in such a proportion as freely to yield the whole of its extractive matter. The "tea" is an excellent drink for sick horses and cattle, and greatly promotes the lactic secretion of cows; it is given either cold or blood-warm; and though sometimes disliked or refused when first offered, it is readily taken when the animal becomes very thirsty, and is afterwards relished. The hay used in making it can be dried and employed for litter.

HAY-TEDDING MACHINE. A two-wheeled and horse-drawn implement for tedding hay. It was invented by Salmon of Woburn about the year 1800, and patented by him in 1816; and it has been considerably modified and improved by recent makers of it, particularly R. Wedlake of Hornchurch. It consists of a skeleton carriage or open cylindrical frame, with a series of revolving rakes along the surface of the cylinder. Mr. Wedlake's improvement consists in having the cylinder in two parts, with motion independent of each other, and in so adjusting the teeth upon a spring-supported bar that they yield to any sudden inequality in the ground, and immediately afterwards return to their ordinary position. Provision exists for pushing back the implement without turning the rakes, and for raising the rakes from the ground, and maintaining them in a raised position, during any period of the machine's motion, as in its progress between the field and the farmery, when their work is not wanted. Even the old varieties of the machine are very efficient and economical tedders, and are so constructed as to admit of the same frame being mounted successively by the tedding apparatus and a horse-rake apparatus, and have found extensive favour, both on the great hay farms in the vicinity of London, and in many of the parks and home-farms of great landowners in various parts of the country. Mr. Slight of Edinburgh says, in Stephens' Book of the Farm, respecting the improved variety of the implement manufactured by him, "The result of the combination of the geering is, that the revolving rake makes 4½ revolutions for one of the carriage-wheel. The latter, being 3 feet 10 inches diameter, will pass over 12 feet or thereby in one revolution; and the rakes being 4 feet 6 inches diameter over the extreme points of the teeth, will describe a circle of about 14 feet in circumference, and this revolving 4½ times for one of the other, the points of the teeth will pass through 63 feet while the carriage has moved over 12 feet, and as there are 8 rake-heads, there will be $8 \times 4\frac{1}{2} = 36$ contacts with the substance which is to be lifted, in a space of 12 feet, or one at every four inches. From this calculation it will be seen, that the hay under the operation of this machine will undergo a process of teazling or tedding of the most perfect description; it will be separated and tossed about until no two stems of the plants will be left in contact; and by this exposure, the drying process is effected in a period greatly shorter, and more effectually, than could be done by any number of hands. Thus, if we suppose the horse to walk 2½ miles per hour, and the machine to cover 6 feet in breadth, we have a surface of 1½ acres nearly covered in an hour." This implement is represented in *Plate XXVII.*

HAYNING, or Hayning-Up. See Haining of Grass.

HAZEL, — botanically *Corylus.* A genus of plants of the family Amentaceæ, containing six species, all confined to the northern hemisphere. They are shrubs or small trees, with simple, alternate leaves. The male flowers are in long, cylindrical aments or catkins; and the fruit, consisting of a nut, marked, at base, with a large cicatrix, is enveloped in the persistent calyx, which is irregularly toothed on the margin.—The European hazel, *C. avellana,* from cultivation, has produced several varieties, differing in the size, shape, and flavour of the nuts, which are commonly known under the name of *filberts*. See the article Filbert. The American hazel, *C. Americana*, very much resembles the European, but is humbler in stature, and the calyx is larger than the included nut. The flavour of the kernel is, by many, preferred to the filbert, though we know of no attempts to improve it by cultivation. It is common in most parts of the U. States.—The *C. rostrata*, distinguished by having the calyx prolonged beyond the fruit, in the form of a long beak, and very hairy, is much rarer than the preceding, but occurs sparingly as far south as Boston, and was introduced about 100 years ago to Britain. The other species are *C. humilis*, 6 or 7 feet high, a native of North America; *C. tubulosa*, 10 or 12 feet high, a native of the South of Europe; and *C. colurna*, about 10 feet high, a native of the country around Constantinople. See the article Byzantine Nut.

The oil which is obtained from hazel-nuts by pressure, is little inferior in flavour to that of almonds; and under the name of *nut-oil*, is often preferred, by painters, on account of its drying more readily than any other of the same quality. Chemists employ it as the basis of fragrant oils artificially prepared, because it easily combines with, and retains odours. This oil is found serviceable in obstinate coughs. If nuts be put into earthen pots and well closed, and afterwards buried 18 inches or two feet deep in the earth, they may be kept sound through the winter.—In many parts of England hazels are planted in coppices and hedge-rows for several useful purposes, but particularly to be cut down, periodically, for charcoal, poles, fishing-rods, &c. Being extremely tough and flexible, the branches are used for making hurdles, crates, and springles to fasten down thatch. They are formed into spars, handles for implements of husbandry, and, when split, are bent into hoops for casks. Charcoal made from hazel is much in request for forges; and, when prepared in a particular manner, is used, by painters and engravers, to draw their outlines. The roots are used by cabinet-makers for veneering; and, in Italy, the chips of hazel are sometimes put into turbid wine for the purpose of fining it.

HAZEL-LOAM, or Hazel-Mould. A particular variety of fertile soil. See the article Soils.

HEAD. The part of the animal body which contains the brain and the higher organs of sense. In many animals, it is connected with the trunk, by the neck, and is more or less moveable; in some animals, however, it is immoveable, and is merely a prolongation of the trunk. The head in animals is more distinct in proportion as the brain is more fully developed as the centre of the nervous system. It is entirely wanting in the lowest classes of animals, which, therefore, from the intestinal worms downward, form a third class, in the system of Latreille, under the name of *Acephala* (headless animals), while those provided with heads are divided into two classes, the *Vertebral animals*, having distinct and proper heads, and the *Cephalidia*, having small and less distinctly formed heads. In this part the mouth, as the opening of the œsophagus, is always situated. In the second class of animals, in which the head is less distinct, that part of the body which is provided with the mouth, may be called the *head end*. In the vertebral animals (mammalia, birds, reptiles and fish), the head has a bony basis (cartilaginous only in the cartilaginous fishes). In fishes, the bones of the head are not united with each other; and the formation of the separate bones is various. In cartilaginous fishes, the head is more or less oblong and angular; in osseous fishes, it is less flattened, and composed of a considerable number of bones connected in various ways; in all fishes, the cavity of the brain is very small and oblong. Equally various is the formation of the head in the different classes of reptiles. In general the head is composed of few bones, and more rounded in proportion as the brain is more developed. In birds, the bones of the head are more closely formed into one whole, constituting a skull more or less round, which contains the brain, and to the fore part of which the beak is attached. But the head is most perfect in the mammalia, and resembles the human head more nearly as the animal approaches more nearly to man. In general, the human head may be considered as the standard, which may be traced, with gradual deviations, through the different classes, until it entirely ceases in the lower orders of animals. Nowhere is its proper office, to serve for the reception of the nervous system, so distinct as in the human head; the cavity of the skull containing the principal organ of sensitive life—the brain; as the great cavities of the trunk contain—the chest, the organs of irritable life (the heart and lungs), and the abdominal cavity, the organs of the reproductive life (the organs of digestion and generation). The superiority of the head over the other two parts just mentioned, appears also from the circumstances, that whilst it is pre-eminently the seat of the nervous system, it also contains organs essential for functions of the irritable and reproductive system; as the inspiration and expiration of the air are effected through the nostrils and mouth, and the entrance of food into the abdominal cavity, as well as the preparation of it for digestion, by mastication and the production of saliva, is effected by the mouth; and these organs appear more prominent, in the heads of animals, as their sensitive system sinks lower in the scale. It must not be forgotten, that the head also contains the tongue, an organ not only important in respect to nourishment, but also communicating the desires and thoughts, until it becomes in man the organ of oral intercourse, of language, and of the finest music—singing. The human head, and, more or less, the head of other animals, is divided into two chief parts, the skull and the face. The importance of the head as the noblest part of the animal system, has occasioned it to be used metaphorically, in all languages, to denote that which is chief.

HEADING-DOWN. The beheading of young ligneous plants, with a stroke of the pruning-knife. It is an operation of the highest importance, and all but essential to proper growth and future vigour, in the case of all stoling non-resinous trees, which do not rise with a single leading stem, and grow boldly and freely, within three or four years of being planted; and it ought to be so unsparingly performed on all such as to cut them down to within 3 or 4 inches of the ground. "The cut," says Lang, "must be made with the pruning-knife, in a sloping direction, with one effort. Great care should be taken not to bend over the tree in the act of cutting. By so bending, the root may be split,—a thing which too often happens. The operation should be performed in March, and not at an earlier period of the season; because the wounded part might receive much injury from the severe weather in January and February, and the expected shoot be thereby prevented from rising so strong and vigorous."

HEAD-LAND. The cross-ridge extending along the end of a field, and employed as the space for the turning of the plough and the grubber in the processes of tillage. Its surface acquires an accumulation of rich soil and manurial matter from the exit upon it of the plough from the furrows; and is, therefore, frequently made into a compost with lime for the re-enriching of the field.

HEALING. The cicatrizing or skinning of wounds. "Healing ointments," in the practice of farriery, are numerous and very various; but most are either useless or positively injurious. When a wound is fungous, purulent, or in any way unclean, it requires treatment preparatory to healing, or treatment to remove its diseasedness of condition; and when it is free from disease and in all respects a clean wound, it requires only to be kept clean and protected from injury and from the action of the air, in order to heal of its own accord. When a wound is clean, any substance which simply keeps it snug is worth all the healing ointments in the world; and when a wound is obstructed from healing by only slightly morbific action, the preparation known as Turner's Cerate, is greatly preferable to any other ointment. See the articles Calamine and Wound.

HEARING. The perception of sounds. See the article Ear. The hearing of the horse is so acute as to receive vivid impressions from vibrations of the air far too slight and faint to be possibly detected by the keenest human ear. The hunting-horse, for example, hears the cry of the hounds, and erects his ears, and becomes excited and impatient, a considerable time before his rider detects even the faintest sound. The fine condition of this sense in so useful an animal, like the keenness of smelling in the dog, and the peculiar development of the senses altogether in the species of animals which subject themselves to domestication, is a very palpable evidence of the bounty of the Creator to man.

HEART. A hollow, muscular organ, the function of which is to maintain the circulation of the blood, and which is of different formations in different animals. The organs of circulation are the heart, the arteries, the veins, and the capillary vessels. The blood is divided into the arterial blood and the venous blood. The object of the circulation is to carry the venous blood, which has returned from the body, into the lungs, where, by the influence of the air, it is converted into arterial blood, which is then again sent out into the system, to nourish it and repair its losses. The heart in men, quadrupeds, and birds, is composed of four cavities, two auricles and two ventricles (thence called *double*). It is enveloped in a membrane called the *pericardium*, situated toward the left of the cavity of the chest, between the lungs, and resting on the diaphragm. Its form is that of a cone flattened on its inferior and superior faces, the latter formed principally by the right, the former by the left auricle and ventricle. The right auricle communicates with the right ventricle, besides which there are in it three openings, that of the *vena cava inferior*, that of the *vena cava superior*, and that of the coronary vein. The communication between this auricle and ventricle is closed by a valve when the heart contracts. The right or pulmonary ventricle communicates with the pulmonary artery, which is provided with three valves. When these valves are brought together, they interrupt the communication between the ventricle and the artery. The left auricle communicates with the left ventricle, and contains also the orifices of the four pulmonary veins. The left ventricle, besides the communication with the left auricle, contains the orifice of the aorta. The ventricles are divided from each other by a fleshy wall, called the *septum cordis*. The valves at the openings of the arteries are called *semilunar;* that at the orifice of the right auricle, *tricuspid;* that at the orifice of the left auricle, *mitral;* and that at the orifice of the *vena cava inferior*, the *Eustachian* valve. The heart is formed of a firm, thick, muscular tissue, composed of fibres, interlacing with each other. It is also composed of nerves, membranes and vessels. The coronary arteries arise from the aorta, and are distributed on the heart. The coronary veins return the blood of the heart into the right auricle. The arteries are the vessels which serve to carry the blood from the heart to all parts of the body. They terminate in the capillary vessels—a series of extremely minute vessels, which pass over into the veins. The veins are the channels by which the blood passes back from the body into the auricles of the heart. The blood which is returned from the veins is black, and is called *venous;* that which leaves the heart is red, and is called *arterial.* The red blood, possessing nourishing and vital properties, rises in the capillary system of the lungs, flows into the pulmonary veins, thence is received into the left cavities of the heart, from which it passes into the aorta, and is transmitted to all parts of the body, to the capillary system. It there loses two degrees of temperature, and undergoes other changes, by the loss of some of its elements in the important functions of nutrition, calorification, and the secretions. It is now become black, passes through the veins, from the extremities of the body towards the heart, receives the chyle and the lymph, and is emptied into the right cavities of that organ, which returns it, through the pulmonary artery, to the capillary vessels of the lungs, where it is subjected to the influence of the air, resumes the qualities of red or arterial blood, and is ready for a new course. Having thus described the route of the blood through the different parts of the system, we will now explain the mechanism of the sanguineous system. The blood contained in the two *venæ cavæ* is poured into the right auricle, which contracts, and thus forces the fluid to escape; but the *vena cava superior*, opposes to its passage the column of blood which it contains, the other veins are closed by valves, and it must therefore pass into the right ventricle. The ventricle then contracts, and the tricuspid valve closing the passage through which the liquid entered, it is forced forward into the pulmonary artery, which contracts, and its orifice being closed by the semilunar valve, propels the blood still forward into the capillary system of the lungs, whence it passes into the pulmonary veins, which pour it into the left auricle by their four orifices. The contraction of the auricle impels it into the left ventricle, by which it is, in the same manner, driven forward into the aorta (the mitral valve preventing its return into the auricle), and thence into the general circulation as above described. The two auricles contract and dilate simultaneously with each other, as do also the two ventricles. The dilatation is called *diastole;* the contraction *systole.* It is difficult to determine what quantity of blood the heart projects at each systole. It is generally estimated at two ounces. The causes of the alternate contraction and dilatation of the heart are not less difficult to decide. They are entirely involuntary and dependent on the nervous system. The force of its contractions is likewise unknown. The systole of the ventricles is the cause of the motion of the blood in the arteries, which also dilate with each wave driven into them by the motion of the heart. By what means the blood is made to penetrate the thousand windings of the capillary system, and what causes impel it to flow back through the veins, are yet subjects of dispute among physiologists. The time in which a drop of blood completes its circle of motion, has been differently estimated, at from 24 hours to 2 minutes. Among the lower orders of animals, the organization of the circulating system is very different. The infusoria, polypi, and intestinal worms have no distinct vessels, much less a heart; the echinodermata have distinct organs of circulation, but no part resembling a heart. Insects have a small cylindrical vessel, running along the back, which is rather the rudiment of a vascular system, than of a heart. The first traces of a heart are found in some worms, in which some expansions are perceptible in a part of the vessel which runs the whole length of the body. In the spiders, lateral vessels are given off from the main vessel, and a pulsation is perceptible. The crustacea have a heart composed of one fleshy ventricle. In the mollusca, the heart appears completely formed; some of them have three cavities. The four classes of vertebral animals have red blood, but fishes and reptiles have only what is called a *single heart*, that is, composed of one auricle and one ventricle.

HEART'S-EASE. See VIOLET.

HEART-SEED,—botanically *Cardiospermum.* A genus of tropical climbing plants of the soapberry tribe. Seven or eight species have been introduced to the botanical collections of Britain; and a number more are known. Most or all are annuals, and have a curiously ornamental appearance. The stem of one of the longest known is channeled, branched, and 4 or 5 feet high; the leaves and the flowers grow on very long footstalks; the flowers are small and white, and comprise each four petals; and the seeds are round, hard, and of the size of small pease,—and each has a black, heart-shaped spot, which is alluded to in both the popular and the botanical name of the genus, and which has also occasioned both the plants and the seeds to be sometimes called heart-pease.

HEAT. See CALORIC.

HEATH,—botanically *Erica.* A very large, prominent, and beautiful genus of evergreen, shrubby plants, constituting the type of the natural order Ericeæ or Ericaceæ. This order is characterized by the dry shrubby habit of its plants, by their awn-like anthers, and by their polyspermous fruit. About 14 hardy herbaceous species, about 260 hardy ligneous species, about 700 greenhouse species, and 7 or 8 hothouse species of it exist in Britain; and these are distributed among 28 genera, and grouped into four tribes,—the true heaths with 15 genera, the rhodora tribe with 10 genera, the pyrola tribe with 2 genera, and the monotropa tribe with one. The whole order is remarkable for beauty; every genus contains plants well worthy of cultivation; and the true heath and the rhodora tribes comprise a very large proportion of the finest flowering shrubs of at once the greenhouse, the conservatory, and the open ground. The principal genera of the true heaths are erica, arbutus, andromeda, menziesia, clethra, gualtheria, and enkianthus; and the principal genera of the rhodoraceæ are rhodora, rhododendron, azalea, kalmia, and ledum.

The heath genus comprises at present about 600 species within Britain, or very nearly three-fifths of all the species of the order; it includes also a considerable number of varieties and hybrids; and it possesses so great prominence and importance in its contributions to horticultural decoration, as to appropriate to itself, under the name of heath-houses or heatheries, entire buildings or apartments in the glazed structures of very many gardens. Five of its species grow wild in Britain; 8 are natives of the South of Europe, and 2 of France and Germany; and all the rest have been introduced from the Cape of Good Hope. Even the indigenous and the Continental species are beautiful; and the African species—though often enough presenting an uncouth and rubbishy appearance in their native country, and sometimes overrunning patches and districts of it in a manner annoying to the natives—possess eminent and commanding celebrity in the gardens of Britain,—insomuch that he who knows little of "the Cape heaths" has yet to commence acquaintance with the contents and almost with the very uses of our conservatories and our greenhouses. The heaths are not only one of the largest and most elegant groups of ornamental plants, but they possess a rare combination of accompanying properties to render them superlatively attractive. "Of what other genus," remarks Loudon in the Gardener's Magazine, "can it be said that every species, without exception, is beautiful throughout the year, and at every period of the year, in flower or out of flower, and of every size and age? Suppose an individual had the penance imposed upon him of being forbidden to cultivate more than one genus of ornamental plants, is there a genus that he could make choice of at all to be compared to erica,—perpetually green, perpetually in flower, of all colours, of all sizes, and of many shapes?"

One large subgenus, comprising about 120 species, besides many varieties, and consisting entirely of Cape heaths, is characterised by the tubular form of its cylindrical and comparatively long flowers, and has been called tubifloræ. Some of the most handsome species of this subgenus are *E. vestita*, *Plukenetii*, *Peteverii*, *Niveniana*, *Hibbertiana*, *aurea*, *rosea*, *onosmæflora*, *triphylla*, *Sebana*, *exsurgens*, *gemmifera*, *mammosa*, *purpurea*, *grandiflora*, *splendens*, *Sparmanni*, *verticillata*, *Banksiana*, *gelida*, *fasciculata*, *perspicua*, and *cruenta;* and several of these, particularly *vestita*, *Sebana*, *exsurgens*, and *Banksiana*, include a number of varieties.—Another subgenus, comprising about 25 species, and also consisting entirely of Cape heaths, has its flowers in the form of greatly inflated tubes, and is called ventricosæ; and its finest species are *E. cerinthoides*, *Monsoniana*, *acuminata*, and *metulæflora*.—A third subgenus, comprising about 55 species, and likewise consisting entirely of Cape heaths, has its tubular flowers contracted in the upper part, and with a spreading border, and is called limbatæ; it contains a curious-looking species of many varieties, whose name, *E. ventricosa*, is awkwardly identified with that of the preceding genus; and some of its most ornamental species are *E. concava*, *juliana*, *Lawsoni*, *Shannoniana*, *Humeana*, and *Russeliana*.—A fourth subgenus, comprising about 80 or 85 species, and including the common indigenous species of British heath-grounds, has the upper whorls of its corolla enclosed in an inflated calyx, and is called calycinæ; and among its finest species are *E. melanthera*, *elegans*, *turgida*, *fragrans*, *triumphans*, and *Thunbergia*.—A fifth subgenus, comprising 2 European species and about 120 Cape-of-Good-Hope species, has small globose flowers, and is called globosæfloræ; and among its finest species are *E. decora*, *ramentacea*, *margaritacea*, *aggregata*, *mucosa*, *suaveolens*, *racemosa*, *canescens*, and *sanguinolenta*.—A sixth subgenus, comprising 4 of our indigenous species, 8 of the Continental species, and about 115 or 120 Cape species, has small flowers of other forms than globose, and generally somewhat egg-shaped, and is called ovatæflora; and among its finest species are *E. scabriuscula*, *tenuis*, *Solandriana*, *echiiflora*, *depressa*, *alopecuroides*, *retroflexa*, *nana*, *viscaria*, and *pyramidalis*.—A seventh subgenus, comprising about 65 species, and consisting wholly of Cape heaths, has flowers differing more or less in form from those of all the other subgenera, and is called dubiæ; and a number of its species are named from the peculiar form of their respective flowers or leaves, as *E. diotiflora*, *traguliflora*, *squamæflora*, *cerviciflora*, *sacciflora*, *diosmæflora*, *turbiniflora*, *nidiflora*, *ciliciiflora*, *pavettæflora*, *cyrillæflora*, and *cerviciflora*, and *E. hyssopifolia*, *tegulæfolia*, *embothriifolia*, *borboniæfolia*, and *xeranthemifolia*.

Though all the Cape species properly require greenhouse heat, and four or five of the European species properly require the heat of the frame, yet a very fine assortment of heaths may be grown in beds or groups of moist sandy loam, or of loam and peat, in the open ground of any warm situation in Britain, and especially in the southern and central counties of England. All the five native species, *E. vulgaris*, *ciliaris*, *tetralix*, *vagans*, and *cinerea*, may, of course, be included; all the ten continental species, *E. arborea*, *viridipurpurea*, *australis*, *ramulosa*, *stricta*, *umbellata*, *multiflora*, *sicula*, *carnea*, and *mediterranea*, together with their several varieties, may also be included; a few of the most thoroughly acclimitated Cape heaths, or of the hardiest hybrids from them, may likewise be included; and, to enhance the effect, some hardy ericaceæ, of other genera than erica, and most akin to it in habit and appearance, such as the menziesias, may be intermixed. Not only so; but many of the very finest of the Cape heaths, which cannot live in winter without greenhouse heat, might be so grown in beds or borders under a moveable roof during the winter half of the year, as to have both the place and the appearance of an open-ground-group during the summer half. "We do not allude," to adopt the words of Loudon, "to those moveable roofs, where, when the sashes are taken off, the rafters, walls, and flues remain to disfigure the scene. To these there can be no objections in kitchen gardens; but in ornamental scenery, the roof should be so completely removed as to leave no traces of its appearance. This might easily be done by supporting it on moveable iron props, which might fit into fixed sockets, and by having the flues under the paths. For six months of the year, the Cape heaths so grown, would appear like a clump of hardy shrubs; and if they were planted on a rocky slope, or the surface arranged somewhat according to the native soils and situations of the plants, but not overdone, the illusion would be greater."

All the Cape heaths may be readily propagated from cuttings. Young shoots fit for the purpose may be obtained from the beginning of February till the end of July; and those of some species, as *E. Sebana* and the several kinds which have a chary or stinted growth, can seldom be had more than half an inch in length, while those of others, particularly of the free-growing kinds, may be obtained of much greater length, yet need never be used of more than an inch. The pots intended for the cuttings, ought to be filled with draining-matter to the depth of two inches, with proper heath mould up to the level to which the lower end of the cuttings will penetrate, and with fine river sand or with a mixture of one-fourth of white house sand and three-fourths of well-washed pit sand, from the surface of the heath mould to the level of the summit; and each ought to be provided with a bell-glass which will stand a quarter of an inch within the rim. The compost in the pots should receive a gentle watering to make it firm; the foliage must be carefully stripped off from at least one half of each shoot intended for a cutting; and the operator, placing the root end of the shoot on his thumb-nail, and using a sharp pen-knife, ought to cut the shoot clean through, as near as possible to a joint, and where the wood exhibits not the slightest appearance of ripeness and at the same time feels firm under the edge of the knife. Fifty cuttings may be so neatly and closely planted in rows as to be covered by a bell-glass of 6 inches in diameter; and if marked with their different names or otherwise properly distinguished, they may comprise a considerable number of species or varieties. After planting the cuttings, a gentle watering should be given to consolidate the sand; and after the pots have stood for a few minutes to allow the surface to become dry, the bell-glasses should be placed upon them, and sufficiently pressed into the sand to exclude the air. The pots may be placed on a shelf in a warm part of the greenhouse, or in the coldest part of a plant-stove, at a distance from the flue; and they need not by any means be in a shady situation, yet ought to be shaded or to be covered with some opaque substance when exposed to the direct play of the sunshine. Watering ought from time to time to be regularly and fully given,—else the cuttings will become hard, and either lose the power of rooting or be very slow in developing it; yet, except during the waterings, the glasses ought never for a moment to be removed till the cuttings have fairly struck.

Propagation of Cape heaths from seeds, though much less generally understood than propagation from cuttings, is quite as practicable, and requires less labour, and, in some species, is followed as early by the commencement of bloom. Seeds usually arrive, in greatest quantity, in July and August, and they may be sown at any time between the beginning of the former month and some time after the end of the latter. They ought to be sown somewhat thinly; for if sown thickly, the young seedlings are liable to be injured by the process of thinning out. Some have been known to vegetate well 12 years after being imported; but those of different species, even when all alike good and fresh, do not vegetate with equal rapidity. The pots for them ought to have a sufficiency of drainage to allow a free passage for the superabundance of water during the winter months, and should be filled with soil rather sandy than boggy. The plants which come first up ought to be separated from the rest, and exposed to the air, and should receive less water than those of slower development and only yet germinating; and though a free supply of water will do no injury so long as the plantlets are beneath the soil, yet the drier all the developed and risen seedlings are kept throughout the winter, the less likely will they be to damp off during the cold weather, and the hardier in constitution and the fitter for potting will they be in the early part of spring.

Ericæ are liable to be damaged by frequent shifting, and do not thrive long in any kind of very finely sifted soil, and they ought to have some changes in the quality of the soil at each successive shifting, and should always be treated in the manner of plants which naturally inhabit sterile soils, in rugged and moorish situations. They occur, in their wild state, on grounds of a widely different character from those which are naturally inhabited by the great majority of greenhouse plants; and they require to have a somewhat corresponding difference of treatment. For example, *E. colorans*, *tubiflora*, and *Linnæoides*, naturally inhabit a black vegetable soil, in running waters and spouty grounds; *E. albens*, *ampullacea*, *retorta*, *ardens*, *fastigiata*, and *fascicularis*, inhabit shattered sandstone rocks with little or no soil, and attach their roots to the stones in the crevices of the rocks; *E. gelida, eriocephala, halicacaba,* and *caffra,* inhabit bare shattered rocks, and especially moist clefts, at elevations of 2,000 or 3,000 feet above the level of the sea; *E. viscaria, viridiflora,* and *blæriodes,* inhabit disintegrated sandstone rocks, overshaded by rushes and other similar coarse vegetation; *E. Plukenetii, sebana, sexfaria,* and *baccans,* inhabit disintegrated schistose rocks in the lower parts of mountains and hills, exposed to drought; *E. calycina, gracilis, Walkerii, Massoni,* and *retorta,* inhabit arid sands, exposed to heat and drought, at elevations of from 2,000 to 5,000 feet above the level of the sea; *E. metulæflora, cerinthoides, grandiflora, ignescens,* and *mammosa,* inhabit sandy ground on the plains, particularly in places which abound with natron; *E. vestita, filamentosa, cruenta, versicolor,* and *triflora,* inhabit loamy ferruginous grounds, in both high and low situations, exposed for several months of the year to great drought; *E. persoluta,* and *urceolaris,* inhabit the disintegrations of schistose rocks, by the sides of streams, in deep shaded glens; and *E. discolor* and *hirta* inhabit stiff loamy ground, in moist glens and on the margins of woodlands, in company with pelargoniums, rushes, sedges, and other kinds of coarse and rank vegetation. The soils which nourish the greatest proportion of ericæ throughout the Cape appear to be debris, arid sand, and ferruginous loam; and even those moist ones which nourish a considerable proportion have little similarity to our bogs or even to the black mould of our moors, but seem to owe their suitableness far more to their mineral than to their organic constituents. In the artificial culture of ericæ, therefore, bog earth ought to be not at all or but very sparingly used; a good proportion of sand ought to exist in all the peaty or moorish soil employed; a considerable artificial admixture of porous sandy loam strengthens the suitable properties of the sandy peat; and even an admixture of debris, or small angular fragments of sandstones and schists, or almost any kind of coarse mineral matter, may sometimes be serviceable. Mr. Bowie, the botanical collector at the Cape, recommends for the first potting-off of seedlings a compost of one-fourth of sandy loam and three-fourths of sandy peat,—for the first shifting, one-half of sandy loam and one-half of sandy peat, —for the second shifting, three-fourths of sandy loam and one-fourth of sandy peat,—and for the third and if possible the final shifting, all sandy loam; and he adds, "Stones or even broken fragments of garden pots, of one-fourth to one-half inch in diameter, seem beneficial to the health of ericæ, while finely sifted soil consolidates into an unwholesome and stagnate mass, preventing the free passage of superfluous water." Fire heat, smoke, and a continuance of confined air are injurious; and fresh air, even in pretty cold weather in winter, ought to be freely admitted.

The ling or heather or common heath of Britain, *Erica vulgaris*—called by some botanists *Calluna vulgaris*—is too well-known a plant to require any description. It covers many thousands of acres in the highland districts of Scotland and Ireland; and abounds in similar climates and situations throughout the continent of Europe. It has a bushy habit, and commonly a height of from 6 inches to 2 feet, but frequently attains a height of 3 or 4 feet; and it usually blooms from February till July. The normal plant has single purple-coloured flowers; but one variety has double purple-coloured flowers, one has white flowers, one has scarlet flowers, and four have various hues of red,—and all these varieties occur in a wild state, and seldom attain more than one-half the height of the normal plant. The botanical names of these seven varieties are *E. v. flore-pleno, alba, coccinea, spicata, decumbens, tomentosa,* and *variegata.*—The common heath is much used for thatch, small brooms, coarse ropes, and generally as a substitute for either straw or the common broom plant. The tender tops and young shoots of it are eaten, in both a green and a dried state, by goats, sheep, cattle, and even horses,—especially in places where the grasses and other herbage plants do not afford a good bite till late in spring; they also form a chief food of grouse, and render the luxuriance of heath upon the moors a desirable object with sportsmen and other partisans of the game-laws; and they are likewise used in the cottages of the Highlanders, as a substitute for mattresses. The heath plants and the dried soil in which they grow are, in many instances, jointly used for fuel; but are much inferior for this purpose to the common produce of turbaries. The flowers yield to bees a honey of a dark colour and peculiar flavour,—preferred by many persons to any variety of honey obtained in cultivated districts; the young shoots have sometimes been used, along with some malt, for making a kind of ale; and the whole plant yields a yellow colouring matter, which can be used for dyeing wool, and a tannaniferous extractive, which can be used in manufacturing leather. The proper management of lands which are overrun with heath will be noticed in next article.

The tetralix heath, *Erica tetralix,* inhabits the moist heath lands of Britain; and though a rare plant as compared with the preceding, is far from being uncommon, and boasts the display of much elegance and beauty in combination with fitness for economical purposes. Its roots are creeping; its stems are erect, and from 4 to 18 inches high; its leaves are crowded, revolute, and downy, and grow four in a whorl; and its flowers stand on finely pubescent footstalks, and grow in round, dense, terminal clusters, and droop pendulously to one side, and have a delicate wax-like appearance, and bloom from June till August. It comprises one variety with snow-white flowers, and another with delicately flesh-coloured flowers; and it may be said, in general, to sport every variety of tint between the purest white and the most blushing rose.—The grey heath, *Erica cinerea*, abounds on dry turfy heathlands, in many parts of Britain. Its habit is bushy; its stems are usually about a foot high; its branches are numerous, upright, leafy, and hoary; and its flowers have a crimson or purplish colour, with a tinge of blue or grey, and bloom from June till September. One variety with white flowers, *E. c. alba*, sometimes occurs in company with the normal plant; and three varieties, with respectively red, flesh-coloured, and dark purple flowers, *E. c. rubra*, *carnea*, and *atropurpurea*, occur in moist heath lands.—The wandering or Cornish heath, *Erica vagans*, abounds in the heath lands of Cornwall. Its stem is usually from 12 to 24 inches high; its branches are numerous; its bark is pale, smooth, and deciduous; and its flowers are red and bloom in July and August. A white-flowered variety of it, *E. v. alba*, is sometimes met with; and a tender-looking, red-flowered variety, *E. v. tenella*, has been introduced to our heatheries from Continental Europe.—The ciliated heath, *Erica ciliaris*, also occurs wild in Cornwall; but though common enough in collections, is scarce as an indigen. Its stem is usually about 12 or 15 inches high; and its flowers are purple-coloured, and bloom from July till September.

HEATHER. See HEATH and HEATHS.

HEATH-GRASS. See TRIODIA.

HEATHS, or HEATH LANDS. Either pastoral or waste lands, more or less overgrown with heath plants. They are of vast aggregate extent in the hilly parts of England, in the mountainous parts of Ireland, and especially in the Highlands, the mountainous lowlands, and the western Islands of Scotland; and they have great diversity of soil, of subordinate vegetation, and of comparative value or worthlessness, ranging from absolute and irretrievable wastes to deep and fertile surfaces, easy of reclamation and fully capable of subjection to the plough; but they may be classified into hilly heaths, possessing much herbage and considerable variety of vegetation,—moorland heaths, with some portion of peaty soil and a great profusion of heath plants,—and sandy heaths, containing very little vegetable matter, and consisting principally of silicious surfaces, matted with the roots of coarse grasses, and sparsely shaded with stunted heath plants and dwarfish furze. The plants which give name to these lands are noticed in the latter part of the article HEATH; some special varieties of the lands themselves are the topics of the articles BOG, DOWNS, and MOOR; and methods of treatment proper for reclaiming, improving, or managing some or all are discussed in the articles DRAINING, IMPROVING OF LAND, PASTURE, and WASTE LAND. Any topics, therefore, which are more proper to these articles than to the present one, must here be either entirely omitted or but slightly touched.

Hilly heaths, as distinguished from moorland heaths, comprise all the best kinds of heathy land, and have peculiar characters of both soil and vegetation; yet they are quite identical with moorland heaths in some great properties, and insensibly graduate into them in almost all others; so that many things which may be said respecting the poorer kinds of hilly heaths may be said also respecting the better kinds of moorland heaths, and some things which we shall reserve to say respecting the moorland heaths, might be said also respecting the hilly heaths. The sandy heaths, in general, are pretty distinct from most of the moorland heaths, and entirely so from nearly all the hilly heaths; and yet even they might share in some remarks which must be made upon both these classes.

Hilly Heaths.—The soil of hilly heaths has generally an ochreous yellow colour, sometimes approaching a brown; it not unfrequently possesses both the appearance and the qualities of a fine hazel loam, and wants only sufficient depth to be capable of becoming prime arable land; and it seldom or never lies on the hard and retentive kinds of subsoil which are commonly termed till and moorland. Its grand defects are prevailing shallowness, an enormous intermixture of both small and large stones, and numerous projections, uptiltings, and mimic expanses of bare rock. A vast aggregate of it might easily be subjected to very productive cultivation by means of the spade husbandry; but only patches of some of it, and comparatively small tracts of even the best, can be disposed into series of ordinary farm-fields for aration by the grubber and the plough. In some parts, rills gush out from the higher grounds, and wander and spread athwart considerable extents of surface, filling up small hollows with water, rendering breadths of declivity wet and spouty, and maintaining the growth of junci, carices, and other coarse and worthless aquatics; but in the great majority of parts, springs limpidly discharge themselves by narrow and well-worn channels, or rills are gulped promptly and completely down by fissures in the rocks or rocky subsoil, so that a large proportion of the surface is almost as dry as that of well-drained grass lands.

The chief plants which inhabit hilly heaths are heath-plants, furze, broom, juniper, fern, and grasses. The heath-plants are frequently tall, luxuriant, and in great abundance; the fern occurs in quite dry situations, and is sometimes very plentiful, and always indicates by its presence the porosity of the subsoil, the comparatively high fertility of the soil, and the presence of a very considerable proportion of disintegrated alkaline rocks; and the herbage includes, not only such coarse grasses as occur on other kinds of heath lands, but also some of the nutritive sorts of agrostis, the sheep's fescue, the woolly soft grass, the annual meadow grass, sometimes the Welch fescue, and occasionally white clover. The higher and drearier tracts of the hilly heaths are the resort of the plover, the lapwing, grouse, the blackcock, the fox, and some other wild animals, and afford more or less sustenance to the goat, the hardy black-faced sheep, the small Welch mountain sheep, and the small Irish highland sheep; and the lower and more fertile tracts, are comparatively free from the heath-plants and abundant in the nutritive grasses, and afford sustenance to the Cheviot sheep, to various half-hardy cross-breeds of sheep, to the small Welch black cattle, to the Kerry black cattle, to the Scottish kyloes, and to some other breeds of black cattle, both native and cross.

The reclamation of all such portions of hilly heaths as have too shallow a soil for the plough, or as are too much encumbered with stones and protruding rocks to be converted into arable fields, can obviously be carried no further than to convert them into good permanent grass lands; but their reclamation to this extent may, in multitudes of instances, be found comparatively easy, and abundantly compensating. One preliminary measure of great moment is to divert all their excess of moisture at springy points into small artificial drains; and another, of scarcely less consequence, though not so generally adverted to by georgists, is to employ the water drawn off to the drainage in a system of catch-work irrigation. See the articles Draining and Irrigation. If the water issuing from springs be all diverted into drains, aquatic plants will die out and nutritive plants will take their place; and if it be further distributed athwart the arid parts of the surface, in the manner of systematic and judicious irrigation, ferns will speedily disappear, heath-plants and furze will gradually give way, and a fine sward of good, sweet, nourishing natural grasses will everywhere be formed. Yet the heath-plants and the furze of the hilly heaths, as well as those of all the moorland heaths which possess any capacity for pasture, are much more expeditiously and effectively reduced by burning than by irrigation. At any dry period of autumn, a kindling of fire on the windward side of a heath-clad hill, spreads over the whole surface, consumes an enormous aggregate bulk of the heath-plants, and leaves athwart the hill-side only an array of blackened stumps; and in the course of the following spring, a tolerably thick growth of the grasses springs up, to keep possession of a large portion of the ground, during several years, till the fresh shoots from the stems and root-crowns of the burnt heath-plants become bushy enough to resume possession and to provoke another burning. Or when the tops and young shoots of the heath-plants themselves constitute a main part of the food which the lands have hitherto yielded to sheep, piece after piece of the heath-grounds of a stock-farm may be burned, in regular and successive order, so as to maintain a series of stages in the development of the shoots, and afford the sheep a constant supply of food; and, after a series of burnings and depasturings, steadily persevered in and rotationally pursued, the heath-plants will gradually dwarf down and die out, and a sward of good permanent natural grass will obtain entire possession.

The grand art of reclaiming hilly heaths, however, as well as of reclaiming all the best kinds of moorland heaths, consists in a combination of the three processes of paring, burning, and liming. See the article Paring and Burning. The paring of small tracts in ordinary districts, or of somewhat large tracts in districts where labourers are numerous and manual labour is cheap, may be effected by means of the implement variously called a breast-plough, a push-plough, a paring-spade, a denshare, and a flaughter-spade; but the paring of all tracts in other circumstances, is most economically done with the common Dutch plough; and when the surface is sufficiently free from stones, ligneous plants, and other obstructions, a wheel-coulter—or a scarifier, as it is sometimes called—ought to be used to the plough. See the articles Breast-Plough and Paring-Plough. "I should recommend," says Mr. Rowlandson, "that the ploughing and crosscutting should be performed the summer or autumn of the year previous to the operation of burning. The sods, by lying in a rough state, and being subjected to the frost of the winter preceding, thus become tender and friable; and if a large triangular harrow or scarifier, with teeth about a foot in length, be drawn once or twice through the sods during the first dry weather in spring, the same will be prepared for heaping up with a 'bob.'"

The liming part of the process of reclamation is much less expensive on hilly heaths than on moorland heaths. When the soil happens to consist of the debris and detritus of trap, greywacke, or aluminous schistose rocks, so that it possesses within itself a comparatively large store of the alkaline food of plants, it requires no liming whatever,—a circumstance all the happier that districts consisting of these rocks are generally the most distant from supplies of lime; and even when the soil is of the prevailing yellowish or brownish-yellow colour, similar in appearance to fine loam, and largely intermixed with stones, it is sometimes thoroughly benefited by so small a quantity of lime as 20 bushels per acre, and probably seldom requires more than about 40 bushels.

Moorland Heaths.—The soil of most moorland heaths is either a mixture of gravel and peat, ot stonebrash sand and peat, or of materials quite similar to these; it is often incumbered with a great proportion of large boulders, either incumbent upon it, or lying level with its surface, or buried at but a trivial depth; and it generally lies on a subsoil either of hard till or moorland pan, frequently much charged with siliciously quartzose paste, or of a stiff, retentive, barren white or blue clay. Moorland heaths comprise also the waste or peaty or comparatively infertile or positively heathy portions of the wolds and downs of England; they comprehend likewise the enormous aggregate of the moors of Lowland Scotland, and the mountain-bogs of Ireland, of Highland Scotland, and of the Hebrides; they include all the heath-clad or heath-infested tracts of the three kingdoms, which, without being flow-mosses, or having only a shallow depth and a peaty consistency of mossy matter, possess more or less of a peat soil; and they, consequently, are of vast extent, and constitute a main part, not only of all the heaths, but of all the waste lands of the empire. Their available soil usually varies in depth from 4 to 12 inches, and very seldom is greater, except in hollows.

Moorland heaths are distinguishable from hilly heaths, not only by the peatiness of their soil, but by the comparative dwarfishness of their heath plants and their furze, by the absence of ferns, and sometimes by the presence of the bilberry and the dwarf sallow. They abound in carices, junci, and other coarse aquatic herbage; they frequently abound also in some of the coarse kinds of agrostis; but they do not contain, except very scatteredly or on some of their best patches, any noticeable proportion of the nutritious grasses. They frequently possess an appreciable value for the feeding of sheep and the pasturage of young stock; but they owe this scarcely at all to gramineous herbage, and almost wholly to the tops and young shoots of their mere heath-plants and furze. Moisture is almost everywhere in excess; and alkaline matter is nearly at a minimum.

The moorland heaths of almost all Scotland, and those also of many parts of England—some as adjuncts to gramineous pasture-lands, and most as absolute or entire pastures of themselves—are employed in the feeding of hardy mountain breeds of sheep. "To even a careless observer," remarks Mr. W. Hogg, "it will readily occur that, on some pastures, heath must be the principal part of sheep's food, while others, on a different pasture, must taste of it very sparingly. On these two situations, sheep employ it for different purposes. On the first, it enters largely into the mass of food which the animal gathers; it has been their principal support since their infancy; they know of no other, and they have no troublesome desire for the succulent grasses. In the latter, it is medicative; and the perception of the animal prompts to the use of it with no other design. When the stomach is overcharged with soft luscious food, the feelings of the animal admonish it to go in quest of aromatic feeding to accelerate digestion; and this a small quantity of heath does. It warms and strengthens the tone of the stomach, and assists in the dissolution of the aliment, and prepares it for entering the intestines; and as soon as digestion is begun, the animal ejects a good deal of wind, which the warm and pungent nature of the heath is now beginning to dissipate. Sheep who are natives of a heathy pasture, are in no danger of feeding to excess; they only satisfy but do not overburden nature; and though the animal is here smaller in the bone, and the viscera much less, the constitution is sound and hardy, and is in no danger of those maladies which arise from repletion."

The moorland heaths are the main retreat of most kinds of game. The majority of the grouse family, pursued by the sportsman or watched by the gamekeeper, feed upon the tender shoots of the heath-plants, and perform incubation amidst the concealment of their thickety recesses; and these birds abound most of all in the wild, desolate, and remote interior of great districts of mountainous moorland, such as those of the central and western divisions of the Scottish Highlands. Moorfowl, in particular, though sometimes seen in pairs or flocks travelling from one heathy district to another, do not abide in any grassy region, no matter how uninhabited or mountainous, but make their permanent residence only where heath prevails; and they may often be observed, by the traverser of moorland heaths, feeding on the young sprigs of heath-plants, in the shock of the tempest or under the dark gloom of approaching night. Yet, though retreating to the cover of old heath-plants, or of bushy patches between the old and the new, for the purposes of incubation, they disdain to make any use of old heath-plants, and seem to be as much profited as sheep by any process which destroys the rank heath-growth of a moor, and occasions a supply of young shoots and tender twigs. "The moorfowl," says Hogg, "seldom or never feed on old heath; the tender and juicy sprigs of the young germs of heath, they invariably select for food; and except when driven by the blue hawk, I never saw them condescend to seek shelter in it from any creature or any weather. Even in the darkest snow-drifts, they often feed on this young plant, in the most exposed situations; nor will they seek shelter on even the lee side of the hill, until they have gathered together a few grains, when they cower down and let the snow drift them up,—in which situation they continue warm, dry, and comfortable, till the hurricane subsides, and then they spring into the air with all the vigour peculiar to their hardy nature." Numerous species of migratory birds, also, resort to the moorland heaths, during the months of summer, for hatching and rearing their young; and here, away from disturbance by man, and amid the stillness and desolation of a far-spreading solitude, they indulge those fond affections with which all the beings of the animated creation delight to supply the wants and unfold the energies of their offspring.

The periodical burning of the heath-plants, which constitutes but a second-rate improvement of any of the best kinds of hilly heaths, is the only economical improvement of which a large proportion of moorland heaths are capable, and is regularly practised on very many of them, particularly in the mountainous districts of Scotland, under the name of muir-burn. Heath-plants which retain living roots, no matter how entirely destroyed may be their foliage and twigs, or how severely scorched may be their stems, all continue to perform their vital functions, and speedily send out growths of succulent young twigs and leaves. Even when the sap-vessels are shrivelled by the heat to the very surface of the ground, young shoots start up from the old stocks, and ramify themselves into series of mutually intersecting branches, and eventually produce such a profusion of heath herbage as overshadows the whole ground. The burning also cleans the soil from niduses of insects, exuviæ of worms and reptiles, noxious accumulations of unwholesome herbage, and other kinds of impurities and pollutions; and, in many instances, it either occasions a renovated growth of some of the coarse mountain grasses or induces the appearance of *Scirpus cæspitosus* and other slender and somewhat nutrient species of Cyperaceæ. When the operation is performed in suitable weather and in a dry condition of the plants, the whole tract is at once laid open to light, heat, dews, fogs, and all the other agencies of the atmosphere; the smoke scarcely disappears, when flocks of carrion crows everywhere alight upon it, to pick up half-scorched insects which could not escape, and such small reptiles as they know they can manage; and, in a brief period, seeds of gramineæ and cyperaceæ, floating throughout the air, make lodgments on the ground, and commence within its bosom the germination of their respective herbage. The growth of grasses, indeed, when considered in its proportion to the aggregate of the moors, is exceedingly limited; crowds of musci, also, extend athwart open patches, and gather round the roots or beneath the shade of old heath-plants, and form a scurf of moss which resists the destroying action of both the fire and the atmosphere; and the very heath-plants themselves, in some parts of the ground, have so exhausted the soil, as to both its nourishing principles and its power of chemical elaboration, that they must die down for some years to allow it time and facilities for renovation; but the great mass of the heath-plants speedily push themselves out into new existence and young exfoliation, while some possess so ample a hold of the soil and exert so mighty powers of reinvigorated being as to spread their roots far and wide, to drink up all the substances available for vegetation, and make a complete monopoly of the new resources which the process of burning has opened up. A fresh, succulent, and comparatively plentiful herbage is thus provided by means of the burning,—in some districts, partially by the growth of grasses and tender club-rushes,—and in most, either mainly or altogether by the development of young shoots in the heath-plants; and—as in the hilly heaths, so more urgently in the moorland ones, on account of their far greater extent, and the far more general dependence which the stock-farmer has upon them for food to his sheep-flocks—this provision ought to be elicited by a perfectly regular and successional course of burning. "The husbandman," remarks Hogg, "doth not go over his arable ground by a certain rotation of crops with greater exactness, than a heathy pasture should be regularly laid out in heaths of different ages, the oldest spaces annually renewed by burning, when the next in seniority are in their last year. By this means, this shrub is kept eatable through all the season; and even when other herbage is scarce, a browse on young heath is far from being unacceptable. It is invariably said by the storemasters and shepherds, that heath is only valuable through the winter quarter; and I believe the disadvantages and neglect with which this production has been treated, has realized the general report. But how can it be of service, when it is allowed to stand till it is useless? When old, it doth not vegetate till about the middle of June; but when young, its spring is little later than the softer grasses. In the former state, there is scarcely a return of verdure through all the season; but when young, it shoots more than an inch for several seasons, and at all times its germs are eagerly sought for and eaten by the depasturing stock. * * The safest and most general rule that can be adopted, is to burn it whenever it will burn thoroughly and completely; and except the single disadvantage of not yielding sufficient cover to moorfowl during the time of incubation, it is in the young state most beneficial for all creatures whose instincts and habits direct them to a heathy soil for food."

Such moorland heaths as are capable of being profitably converted into arable lands, are most efficiently and cheaply reclaimed in nearly the same manner as hilly heaths, by means of paring, burning and liming; but they require to be far more freely and yet much less expensively drained,—they need no subsequent irrigation,—they may, in any case of excessive mattedness or cohesiveness of surface, have their pared turf torn to pieces by the operation of crosscutting,—and they require a comparatively copious application of lime. See the articles Crosscutting and Paring and Burning. Any attempt to reduce their pared turf by prolonged exposure to atmospheric action, ought to be aided by abundant crosscutting, and in most cases is less efficient and economical than the reduction of the turf by burning, or may even prove, in a very serious degree, a failure. "The result of my experience," says Mr. Rowlandson—who combined great scientific knowledge of the principles of georgy and of agricultural chemistry with extensive practice and observation in the reclaiming of Irish moorland heaths—"is that paring and burning, with liming, is indispensable on this class of soils, and that one hundred bushels of lime per acre is the minimum that ought to be applied; that it will not repay the tenant to perfectly drain, with stones, lands of a moory description, with only a depth of four to six inches available soil, as the cost cannot be estimated at less than £10 per acre, it being more profitable to him to plough the land into flat ridges of eight to ten feet width, and plough or shovel out the soil close to, or an inch below, the subsoil. I had a complete example of the inefficacy of leaving sods to rot, having left four acres for nearly four years to undergo that slow process of decomposition, the result of which was, that the sods were, at the expiration of the four years, nearly as tough as they were the first day they were cross-ploughed." Reclaimed moorlands are generally most profitable when laid down to permanent pasture; yet, in instances where the soil is deep and of good quality, they may be very advantageously kept under a rotation of rape eaten off with sheep, of oats, of wheat, and of 4 or 5 years of grass.

Sandy Heaths.—The soil of sandy heaths consists principally of silicious sand, bound together by the roots of coarse grasses and other comparatively worthless plants; it contains very little vegetable matter, and is sadly deficient in alkaline earths; and it has usually a colour varying from pale brown to deep black, according to the proportion of its humus, with a few intermixed brightly glistening grains of sand. Its vegetation is poor, stunted, and dwarfish, consisting principally of starved innutritious grasses, worthless cyperaceæ, and often an abundance of such weeds as infest arenaceous surfaces; and when any heath plants or furze exist, they are usually of the smallest stature and most haggard appearance. Sandy heaths comprise also the powdery, calcareous, and unpeaty portions of the chalk downs of England; and as an entire class of waste lands, they exhibit an appalling desolation, and are but a degree or two less dismal and barren than the sandy wildernesses of Arabia, and are surpassingly churlish and ungrateful under the very kindliest efforts of georgy to reclaim them. See the article Barren Soils.

The coarse herbage upon sandy heaths must be burned; but paring is only limitedly necessary, the burning of any considerable proportion of the vegetable matter ought to be avoided, and the application of more than a small quantity of lime is uncompensating. Ploughing, cross-cutting, rolling, and grubbing or drag-harrowing will generally be found sufficient; and when one course of these is not enough, a second will, in most cases, achieve every thing which any reasonable reclaimer can desire. "The grand fault of sandy soils," observes Mr. Rowlandson, "is the want of the mineral constituents of plants; it would therefore be advisable, on the breaking up of heaths of this description, that, after the coarse plants are burned, and a slight liming given, the lands should be cropped with turnips, drilled with bones, and a little potash of commerce and guano, eaten off with sheep, and then sown down with appropriate grass-seeds; and this is the only mode that I conceive will ever succeed in improving sandy heaths." In the vast majority of instances, any arable cropping of reclaimed sandy heaths would be sheer folly; but when manure is plentiful, and the soil contains a tolerable proportion of vegetable and aluminous matters, a rotation which shall comprise turnips, carrots, potatoes, buckwheat, rye, and a series of years of grass, or which shall alternate the grass with any two or three of these aration crops, may be found sufficiently compensating.

The proper treatment of reclaimed heath lands, in general, affords great scope for the exercise of judgment and prudence, and varies considerably with the circumstances of the cultivator, and very widely according to the character of the soil and the facilities for manuring. As a general principle, however, either the proprietor who retains the lands in his own possession, or the reclaiming storefarmer, or the improving tenant of an extensive mixed farm, will find it most remunerating to break up the heath lands with an express view to grass, and to convert them into strictly permanent pastures. Reclaimed heath lands are generally remote from the farmery; and when subjected to aration, they can seldom, without undue cost of carriage, receive as much manure in return from the farm-yard as shall restore the principles of fertility carried away from them in the roots or stems or seeds of their crops. The best course, in the great majority of cases, therefore—no matter what be the comparative wealth or poverty of the soil—is, immediately after reclamation by paring, burning, and liming, to sow turnips upon the hilly heaths and rape upon the moorland ones, to eat off the crop with sheep, and then to sow with permanent grasses. The occupiers of small allotments, however, may, in multitudes of instances, prosecute a very profitable rotation of flax, oats, and green crops; and were they aided and protected in their pursuits, by the planting of belts of alder and clumps of larch and of coppice-trees to screen them from the prevailing winds, they might—most advantageously for themselves, for their landlords, and for the general community—reclaim and cultivate many varieties of hilly and moorland heaths, not only in low situations, but at altitudes of from 300 to 700 or 800 feet above the level of the sea.

HEATH (Sea). See Frankenia.

HEATHY LAND. See Heaths.

HEAVEN (Tree of). See Ailanthus.

HEAVING. See Parturition.

HEBENSTREITIA. A genus of beautiful, white-flowered, Cape-of-Good-Hope plants, chiefly evergreen undershrubs, of the verbena order.

About a dozen species, chiefly 12 or 15 inches high, have been introduced to Britain.

HECK. A rack for cattle to feed at; also a kind of door.

HECKLE. An iron comb, used in the dressing of flax and hemp.

HEDEOMA. A genus of ornamental, herbaceous plants, of the labiate order. Two hardy annual species were long ago introduced to Britain,—the thyme-like hedeoma, red-flowered, and 3 or 4 inches high, from France,—and the pennyroyal-like hedeoma, blue-flowered, and 6 or 8 inches high, from North America.

HEDERA. See Ivy.

HEDGE. A fence of living plants, either along a division of ground, or round an enclosure. It serves the purpose of either separation, shelter, or defence; and consists of plants which grow densely, and ramify from the ground upwards, and interweave their branches, and readily grow in a line from seeds or plantlets, and admit of being cut and pruned into the form and compactness of a wall, to any width and height which the purposes of shelter and defence require. Hedges for separation are raised principally along the divisions of gardens; hedges mainly for shelter occur principally on the divisions and round the enclosures of gardens, orchards, and the several kinds of ornamental grounds; and hedges wholly for defence, or combinedly for defence and shelter, are raised principally around the fields of farms. The hedges of gardens and parks frequently consist of box, yew, Cydonia japonica, barberry, beech, or hornbeam; the hedges of villa-grounds sometimes consist of privet, of elder, or of mixtures or alternations of privet, holly, and hawthorn; the hedges of pastoral farms sometimes consist of furze; and the hedges of all kinds of ordinary farms and good enclosures usually consist wholly or principally of hawthorn. The uses and the general principles of enclosures are noticed in the article Enclosure; the varieties and modifications of the several kinds of fences, whether hedge, ditch, wall, mound, or combinations of some two or three of these, are noticed in the article Fence; and the nature, species, and proper treatment of the principal plants employed for hedges are discussed in the articles Hawthorn, Privet, Holly, Barberry, Quince, Box, Yew, Beech, Briar, Hornbeam, and Furze. We shall occupy the present article principally with the discussion of hawthorn hedges,—so shaping our remarks that they may apply either to mere hawthorn hedges themselves, or to combinations of them with ditches or embankments; and we must refer to the articles now mentioned for such modifications as specifically bear upon hedges of other plants than hawthorns.

Hedging Implements.—Implements are required for the three processes of designing the course of the hedge, of forming the hedge, and of cleaning, pruning, and maintaining the hedge.

Three poles are needed for designing a hedge on level ground; and a greater number on curved ground. Each pole may be 1½ inch thick and 8 or 10 feet high; and it ought to be shod with iron on the lower end, painted with glaring colours, such as white and scarlet, at the top, and marked with a graduation of feet and half-feet throughout its length. A common iron measuring chain is needed to mark equal lengths of the parallel hedges, or of the two ends and the two sides, which are to enclose the field; and an optical square is required for determining the right-angles at the corners, or for effecting a true parallelism between the two side-rows and the two end-rows. A stout garden line, at least 70 yards long, with a reel or a strong iron pin at the one end and a strong iron pin at the other, is requisite to mark continuously along the ground the line of hedge adjusted by the previous instruments, and indicated by the poles. A few painted wooden pins, with hooked heads, are desirable, for directing any part of the line along the course of a hollow or a curve. A wooden rule, two yards long, and graduated with feet and inches, is requisite for measuring the breadth of the ditch; and a rod or piece of wood similar to itself, and 2 or 3 feet long, ought to be fixed at right angles on one end of it to enable the operator, when measuring the breadth of the ditch, to mark it off square from the line. But these several implements are required for other purposes on the farm than the mere designing of hedges, and ought to have a constant place in the tool-house of the farmery. The poles are always needed for marking off the breadth of the ridges in aration; the optical square is needed for squaring the land which is to be ridged up; and the chain and line and other articles are serviceable in the designing, measuring, and excavating of drains.

Three men, of equal or nearly equal powers, work with most advantage; and all ought to be expert in spade-labour, and to know well the uses of the most appropriate implements for ditching. A spade most suited to each man's habits is the best; but a spade of the size No. 5 is recommended. A hand-pick is needed to trim the sides of the ditch, and occasionally to loosen the strata for the spade. A ditcher's shovel is required to lift the loose materials from the bottom of the ditch, and to beat the face of the hedge-bank; and it ought to be one foot broad and one foot long, to taper to a point, and to have a shaft of about 28 inches in length. An implement, called a foot-pick or tramp-pick, is needed to disengage boulders from the firm earth; and this has a wooden cross-handle, of any suitable diameter,—a strong metallic shaft, of 3¾ feet in length, of ¾ of an inch to 1¼ inch in diameter, fitted with an eye upon the cross-handle, tapering to a point at the lower extremity, and there curved forward to aid the leverage,—and a tramp or rest for foot-pressure, moveable to either side of the shaft, and made firm upon it at the distance of about 16 inches from the point. A mattock is also required, in some situations, for cutting out strong roots of trees or shrubs which may be encountered in the course of digging. But these implements, like those for the designing of hedges, are more or less required for other purposes on the farm, and ought to be constantly at hand. The spade is required for many a purpose; the shovel and the hand-pick are often serviceable as ancillary to the spade; and both the tramp-pick and the mattock may be of much use in the general operations of draining, ditching, and ordinary georgical improvement.

A sharp, strong, ordinary pruning-knife is needed to dress the thorn plants for planting. A hedge-spade, with a small cross-handle, a shaft of about 3 feet in length, and an iron mouth-piece of about 5 or 6 inches in width, is required for clearing away the weeds and superabundant grass of the hedge-bank beneath the line of the young hedge; and the man who wields it stands in the bottom of the ditch, with his face toward the hedge, and performs his work by a succession of horizontal strokes. A common Dutch hoe, 7 inches wide at the mouth, and 5 feet long in the shaft, is required for clearing away the weeds and superabundant grass from the top of the hedge-bank, and as much as possible from among the hedge-plants themselves; and the woman or tall boy who wields it stands on the top of the bank, with the face toward the hedge, and so turns and twists the implement as to cut out the herbage without injury to the hedge-plants, and with scarcely any scratching of the soil. One or two hooked-headed sticks are required for drawing out any herbage which the hoe has loosened and left among the hedge-plants, or for detaching any weeds which the hoe could not reach; and these are used by women, passing along the ditch after the hoer, and stooping sufficiently to see every part of the base of the hedge. The implements for cutting and pruning are a switching-bill, about 2½ pounds in weight, with a shaft 2¼ feet long, and a blade 9 inches long and 1½ inch broad; a cutting-bill, about 6 pounds in weight, with a shaft 2½ feet long, and a blade 7 inches long and 2½ inches broad; and a light axe, about 3 pounds in weight, with a shaft 3 feet long. But a breasting-knife is sometimes used instead of the switching-bill; and it very much resembles that implement, but is considerably stronger and heavier.

The Preparation of the Ground for Hedges.—Ground which is foul with almost any sort of weeds, but particularly with couch-grass, docks, or other stoloniferous and vivacious plants, requires to be thoroughly cleaned by a process of fallowing, in preparation for hedges; for if such weeds as couch, perennial-thistle, common dock, dandelion, or tussilago be allowed to remain in it, they will not only give the hedges a very slovenly appearance, but very greatly retard the growth and reduce the energy of the thorns. Ordinary arable land, under a well-farmed system of rotation, needs no fallowing preparation; and may, in most cases, be very advantageously planted with hedges, at the period when the lea-ground of the rotation is to be broken up for oats. Land of any kind which is in an infertile condition ought to be as well manured for hedges as for any productive field-crop; and old pasture land ought, along the intended lines of the hedges, to be pared and burned, and thoroughly tilled with plough, grubber, and harrow. But should the intended hedge-lines run across the ridges of arable land, no matter at what angle to them, the expedient of simply filling up the furrows to a level with the crown of the ridge would be far from a sufficient preparation; for the earth used in filling up would shrink, and cause the continuous line of the hedges to depress curvingly at the place of the furrows; and, in any instance in which the general slope declines to the exterior, drains would be required to let off the water in each furrow through the hedge-bank. Arable land, therefore, which is to be traversed by the hedge-rows across the ridges, ought to be hedged, not at the breaking up of lea, but at the laying down to grass, when the spaces for the hedge-lines can be raised and ridged up longitudinally to the required height and breadth, so that the flanks of ground along the sides of them shall form the head-lands of their respective fields. When an old turf wall, or the site of one, crosses the line of an intended hedge, every particle of the earth belonging to it must be carefully removed, and its place supplied with good, fresh, recently-aerated soil; for the base of an old turf wall, cannot, till after the lapse of a great length of treatment, be rendered, by even the most coaxing and stimulating treatment, congenial to the growth of thorn plants.

The Planting of Hedges.—On good dry land, properly cleaned and tilled,—or on somewhat inferior land prepared by trenching,—hawthorns grow well when planted simply along the surface; but on poor wet land, they require to be planted either in the side or on the top of the bank or mound formed of the earth thrown out of the ditch. Planting along the plain surface is usually practised in gardens and shrubberies; planting along the top of a sunk fence is frequently preferred in parks and other ornamental grounds; and planting on the side or on the top of a bank formed from the excavation of a flanking ditch, is much practised in farm enclosures, not only upon poor wet soils, but upon many varieties of both aration and grass lands. The side of the bank is preferred to the top by some good judges, and the top is preferred to the side by others; but each has advantages and disadvantages; and either ought to be preferred to the other whenever the advantages peculiar to it are predominant.

The thorn plants selected for planting ought all to be of one variety, and as nearly as possible of one size and uniform vigour. Plants of one age, whether from the seed-bed or the nursery-bed, have generally a very considerable diversity of diameter, height, and strength, and sometimes comprise several observable varieties of character and habit; so that the adoption of a whole stock of plantlets from one bed, or from a set of contemporaneous beds, evinces a censurable want of discrimination, and is almost certain to be followed by great inequalities and many weak or deficient points in the hedges. Young plants of stout stem and considerable height, on the other hand—plants, for example, of half an inch in diameter at the surface of the ground, and of proportionate tallness,—such as have been exclusively recommended by some old and experienced hedgers—can be obtained only by selection from nursery beds of the first style, and of from two to six years of age; so that a fastidious and excessively exacting choice of them makes enormous demands upon the nurserymen, and cannot be gratified without an amount of cost which may never be compensated by the needless excellence of the hedges. A good medium is to take all the plants of a good seed-bed, standing thin, free from mildew, and of two years' growth,—to select the whole of the vigorous ones, or of such as are nearly uniform in thickness and promise, for the planting of the hedges,—to throw away all the very small and weak ones,—and to transplant the rest into a nursery-bed, to be trained for subsequent removal to the gaps of old hedges, or to any vacancy in a line of fences.

Young plants lifted from either seed-bed or nursery-bed for the planting of hedges, ought, during the time of their being out of the ground, to have their roots kept in a proper degree of moisture. Many hedgers are grossly inattentive to this point; and not infrequently allow the roots to become so exsiccated, that many of the plants perish. The top of each plant from a point about two or three inches above the termination of the yellow bark, ought, immediately before being planted, to be cut off with a sharp knife. The cut must be made with an upward slant, so as to avoid the possible injury to the roots which might be inflicted by cutting downward; and it ought to leave two or three inches of the green-barked stem, so as to prevent the enfeeblement of the young shoot which would be occasioned by cutting close to the yellow bark. The practice of some hedgers is to cut off the tops after planting; but, even when the operator is very careful, and uses a very sharp knife, this practice dislodges some of the plants, and strains or breaks the tender roots of many.—The proper distance between plant and plant in planting, is 4 inches; and the proper depth is exactly that at which they stood in the seed-bed, and which is indicated by the yellow bark. Not only hawthorns, but young plants of almost all kinds, are often injured by being planted too deep, and seldom by being planted too shallow.

The planting of hedges along the sides of banks, formed from the excavation of flanking ditches, has hitherto been so prevalent a practice in many districts, and possesses such peculiar fitness for some kinds of soil, and such strong recommendations for many, that the proper method of conducting it ought to be everywhere well understood. But, in general practice, the plants are set considerably too low—sometimes ruinously too low—in the side of the bank. "They are usually laid in about 6 inches above the natural level of the ground; and a great body of earth is thrown from the ditch, and heaped upon their roots, sometimes 3 or 4 feet thick; by which means the roots of the plants are overloaded by the weight of earth, while they are excluded from light, air, and moisture, necessary to encourage vegetation. Hawthorns are naturally surface-rooted plants. This may be seen in all bushes growing spontaneously in pasture-land, their roots running horizontally near the surface, and sometimes bending out of the ground. When such bushes are blown down, or grubbed up, it is a rare instance to find them with top-roots. A traveller, in passing along a public road, and seeing a stunted scrubby thorn-hedge on the wayside, at a distance before him, may fairly calculate that, upon his arrival at the spot, he will find a great quantity of earth heaped up on the roots of that miserable looking hedge. And quite the reverse in regard to a vigorous growing hedge. People are apt to be led into this error of setting their plants deep, or low in the side of a bank, from observing that when drawn from seed-beds they have top-roots. Seedling thorns, like seedlings of other plants, have top-roots in the first instance; these steady the plants in the ground, until the horizontal roots acquire sufficient strength and extension to support and nourish their tops; and the top-roots having then performed their natural functions, they dwindle, and die gradually. As it has been thus shown that much earth raised over the roots of thorn plants impedes their growth, it is advisable, when large ditches are formed, the surplus earth should be either put into hollows near at hand, or carted away and deposited elsewhere,—but by no means raised on the top of the bank. On the contrary, the roots of thorn plants should never be loaded with more than from one foot to eighteen inches thick of earth, regulated by the nature and quality of the soil. This freedom from a load of earth is the principal advantage derived from planting on the top of the bank."

When a hedge is planted on the side of a bank, much advantage results from the erection of a temporary fence of cut brushwood, or of cut old thorns, along the top. The cut plants are made into lengths of 3 feet, a channel for them is formed with the spade along the top of the bank, the ends of the plants are set into the channel, and the soil is closed up firm upon them to hold them steady, and prevent them from being dislodged by high winds. A contrivance of this kind keeps the soil loose above the roots of the hedge-plants, promotes aeration of the soil around the roots, conducts downward a free circulation of moisture from rain, encourages a rapid growth of the young shoots, and protects them, during the first and second years after planting, from the depredations of rabbits, hares, and sheep. Young thorns, planted either on the plain surface of the ground, along the top of a bank, or on the side of an unfenced bank, are very liable to be cropped and greatly injured by rabbits and hares; and the erection of a temporary fence on the top of a bank, to protect a young hedge on the side of it, prevents the animals from obtaining access to the hedge.

The Weeding of Hedges.—A young hedge requires to be weeded, from time to time, till it is three years old; and all the soil within range of its roots ought to be maintained in a thoroughly clean and porous condition, so as to be freely permeated by both air and moisture. The proper manner of weeding was incidentally noticed in our account of the implements for hedging; only the method there described must be modified to suit hedges on other bases than the slopes of banks, and the use of the hooked sticks may sometimes be advantageously substituted by handweeding. "It is very seldom," remarks Mr. Stephens, in the Quarterly Journal of Agriculture, "that a hedge requires to be so thoroughly cleaned in the first season; but in the second year, it is absolutely necessary to be very vigilant in cleaning early in spring, before vegetation is much advanced. If weeding is delayed till the roots of the weeds take firm hold of the ground, the displacing of them bears away a great deal of earth from the face of the bank. There is no specific time of the season to clean a hedge; but the safe rule is always to clean it before the weeds in the least envelope it. The most common weeds which infest hedges in loamy ground are the tussilago, way-thistle, corn sow-thistle, common dock, sorrel, ribwort, groundsel, hedge-vetch, bindweed, sticking-grass, cow-clover, wild mustard, chickweed, dead-nettle, rest-harrow, great white ox-eye, corn-poppy, white lychnis, blaewort, and several of the grasses. The tussilago, rest-harrow, ox-eye, and docks are most difficult to eradicate; the bindweed, sticking-grass, vetch, and the yellow-flowering trailing plant, interlace the branches of the thorns, and are exceedingly difficult to eradicate; and if there be but a single fibre of the wild mustard attaching the plant to the ground, it will grow again with vigour."

The Pruning of Hedges.—Few hedges ought to be pruned till they are three years old. Hedges of any luxuriant variety of thorn, and growing upon congenial and very fertile soil, usually require in the second year, to have all such lateral branches switched off as overhang the ditch, or otherwise offer a lodgment for snow; but even these derive benefit from this partial second-year pruning, not in the way of any stimulus to their growth, but simply to prevent the branches from being fractured, and the vessels of the circulatory system ruptured, by lodgments of snow or the abrasions of cattle. Hedges on good soil and warm situations will eventually grow well, and merely suffer retardation, under premature or improper cutting; but hedges on poor soil and in exposed situations are very liable to be stunted, cankered, or almost utterly destroyed, if cut in any way till the third year, or if even then reduced with hedge-scissors or any coarse-edged instrument instead of the switching-bill. The somewhat common notion, that the pruning of young thorns strengthens their constitution and increases their vigour, is outrageously absurd; and the equally common one, that a regular pruning twice a-year invigorates the plants, is scarcely a degree more rational. Every hedge before being dressed into the artificial shape which taste and economy require it to assume, ought to possess a sufficient strength of both root and stem to make a firm resistance to the violently grubbing and cropping action which the process inflicts upon it,—and in even very favourable circumstances, it cannot possibly acquire this at an earlier period than its third year; and as to all future prunings, it ought to receive them, not on any blind principle of periodical routine, irrespective of soil, situation, weather, and object, but in rational accordance with its own state of growth, and with the training of it into comparative height or the repressing and coaxing of it into increased bushiness and breadth. Hedge-scissors and instruments of any kind with a pinching, bruising, or hacking action ought never to touch a hedge; and only the switching-bill, the breasting-knife, or the cutting-bill, according to circumstances, ought to be employed in the lopping of twigs and small branches, and a light axe in the lopping of large branches or the cutting of stems, in order that every cut may be clean and smooth, and that all the loppings of the twigs and small branches may be in an upward direction.

The Renovation of Hedges.—The renovating of a young hedge which has been stunted and cankered by excessive or injudicious cutting and pruning, or of an old one which has become thin and bare below and deprived of its compactness and bushiness by a long course of neglect, is usually effected by dressing up its sides nearly close to the stems, or by cutting over the whole of its plants almost close to the ground, or only a little above the root crowns. But this process is often mismanaged, and always requires some judgment and skill. The stunted and cankered young hedge ought to be allowed as free a growth as it can command during two, three, or more years before being cut over; and the old, neglected, open-bottomed hedge ought to have all its decayed plants and rotten stumps, and all the soil in which they stood, very carefully removed, and to be supplied, in lieu of them, with fresh soil in which no thorn plants have grown, and with as strong and vigorous young plants as can be obtained from the nursery-bed. When the side-branches are cut off nearly close to the stems, one or more notches ought, in every instance, to be made with the cutting-bill or the axe, one stroke up and the other down, so as to cut a piece of wood clean out of the stem, and about half-way through it; and by this means, young shoots are made to break out immediately below the notch, —they are obtained in abundance at any desired height of the stem,—they grow in such a manner as not to afford a fracturing lodgment for snow, —they prevent the top shoots from rising up with luxuriance, and appropriating an undue proportion of the sap,—and they amass themselves into the precise form of breadth and compactness from the bottom of the hedge upward, which achieves the most complete renovation.

The thorn plants used for filling gaps at the time of renovating a hedge, ought to have been two or three years in the nursery-bed, to have stood thin in the rows, and to have proved themselves free-growers. In transplanting them to the hedge, they ought to be set in as entire as when lifted, to have their roots kept moist till they are set in, and to have the soil placed low or somewhat hollowedly round their root-crowns, so that moisture may be drawn toward them till their roots become firmly established among those of the old stocks. Crab-plants are intrinsically better than thorn-plants for filling the gaps of old hedges; but they are liable to be barked by rabbits and hares,—and when the *Eriosoma mali*, or American woolly blight, is in the neighbourhood, or may be attracted by near orchards or apple-trees, it seldom fails to attack the crab-plants, and may not only damage but destroy them. See the article APHIS. The soil of gaps does not require to be removed for crab-plants or beech-plants, as for thorn-plants; but it ought to be thoroughly stirred up and well pulverized; and, when the plants are set, it should be levelled low, or scooped into shallow basins round their crown-roots, in the same manner as with thorn-plants, for the catching of moisture.

A method of renovation, similar in principle to the notching which we have recommended in the process of side-cutting, was successfully tried by Mr. Carmichael of Raploch, and is recommended in the Transactions of the Highland Society, as at once a cheap, an easy, and an effectual substitute for the common practice of cutting-over. "I tried it," says Mr. Carmichael, "with uniform success, on hedges which had previously been much neglected, but which could not be cut down without great inconvenience and expense. Many of the stems being almost entirely destitute of lateral branches within two feet of the ground, a horizontal cut or semicircular incision was made in the bark, by which from a quarter to half-an-inch in breadth of both layers of the bark was removed fully half way round the stem. In a few weeks, buds appeared and shot forth, usually close under, but sometimes over the incision. This simple operation, performed by the hedge-bill or a pocket-knife, early in spring, does not seem in the least degree to injure the thorns, for the cut being clean, and not deep, no canker ensues, and it soon closes up again. Indeed, most of the stems are now completely healed, so that nothing remains but a slight scar in the place; the object being to intercept the sap in its ascent, the wood need not be cut, and it is only necessary to remove the narrow belt of both barks; but care must be taken that no shred of the inner bark remains to continue the circulation. The partial interruption thus produced, cannot do any harm, as it merely causes a lateral exertion in the sap vessels to overcome the obstruction, and the sap thus accumulated gives rise to the new branches, so that the same stem may be cut at two or more places if necessary. The artificial branches seldom failed to appear when the stems were healthy, and have sometimes attained a length of two feet the first season. But as such tender twigs are apt to be hurt by frost, if cut too young, they were not touched till the first or sometimes the second spring after, when such as required it were cut off a few inches from the stem, which caused an immediate subdivision of each branch. Thus, by means of these semicircular incisions, and by occasionally cutting out a bare irregular stem, the ragged ill-filled hedges have been continued at the regular height, and at the same time trained into a uniform breadth and thickness, not attainable by any other method."

The temporary renovation of old or neglected hedges, which have become perforated and interrupted by gaps, may be effected—though not at all desirably—by the ancient method of plashing In this operation, the stem ought not to be cut any deeper than is necessary to bend it down with considerable difficulty; the cut ought to be made, not high up, but as near the ground as possible; the end of the plash must be fastened down either by inserting it under a hooked branch of a neighbouring thorn, or by pegging it to the ground with a strong, hooked-headed peg; a wedge-shaped piece of stick should be pushed into the cut, to assist in preventing the plash from starting up; and some well-worked clay ought to be stuffed into the cut, to protect the severed tissues of the wood from the action of rain and sunshine. But this operation, even when most skilfully and carefully performed, merely secures a present advantage at the expense of entailing a greater future evil. "Plashing an old hedge," says Lord Kames, "makes a good interim fence; but, at the long run, is destructive to the plants; and accordingly, there is scarce to be met with a complete good hedge where plashing has been long practised. A cat is said among the vulgar to have nine lives. Is it their opinion that a thorn, like a cat, may be cut and slashed at without suffering by it? A thorn is a tree of long life. If instead of being massacred by plashing, it were raised and dressed in a proper manner, it would continue a firm hedge perhaps for 500 years."

The renovation of a hedge, which grows on the side of a bank, and has merely become unduly dendritic in character, or very dense at the top without continuing to be as dense at the bottom, is, in many instances, effected by a process provincially called "breasting" or "breasting over." Tho hedge is very freely pruned, or exceedingly reduced, in a sloping direction upward, from the root-crowns in the face of the bank to the exterior side of the hedge above the top of the bank. The operator stands at the root of the hedge, with his right hand toward it; he clears away all the small twigs which might mar his great severing strokes upon the stems and large branches; and he strikes the stems and large branches upward with the momentum of full swings of tho right arm, and so receives and guides the back of the bill with his left hand as to steady it for each successive stroke. One stroke is generally sufficient to sever a branch; but several strokes —aided, in very stubborn cases, by a downward cut—are often necessary to effect the severance of a stem. The aggregate direction of the cutting is not in the plane of the hedge, but at so considerablo an angle with it as to go right away from the operator's position, and to slant more rapidly than even the sloping plane of the bank. When the operation is well performed, the "breasted" hedge makes a finer and much more obvious display of nice and dexterous workmanship than any ordinary pruning, or even than the original planting; and when the whole work is done, as it ought to be, in perfectly open weather, it is usually followed, in spring and summer by a very great luxuriance of growth. The subsequent treatment, as to training and pruning, is the same as in a newly-planted hedge.

A fence, called a dead hedge, is frequently constructed, with the thorns cut down in the process of free pruning, of cutting over, or of breasting over, along the edge of tho ditch or the back of the bank, to serve the purposes of protection till the reduced hedge grow up and becomo fully serviceable. "A hedger and an assistant are necessary for this business. The man cuts the stems of the thorns about 3 feet long, with the cutting-bill or axe; and he lays one cut piece abovo another to form a bundle, taking care to add some of the small twigs to each bundle, to thicken their appearance; and he then compresses the whole with his foot, so that the bundle may stick together. He thus makes and prepares several bundles in readiness. The hedger takes his spade, and, fixing on the part where the line of dead hedge is to occupy, he turns up a spadeful of the earth, as whole as possible, as if he were digging a piece of ground of the breadth of the spade. After he has laid this spadeful of earth, so as a bundle of thorns may lean against it in an inclining position, the man hands him one of the bundles. The butt-end of the bundle goes into the spade-furrow, and leans from him against the spadeful which he has placed. The hedger then lifts another spadeful, and places it upon the root of the bundle, and presses it firmly down with his foot, which should be fortified with a clog. He suits the inclination of tho dead-fence to the quarter whence the winds prevail. In this manner, they proceed to form the whole line of dead-hedge. As the fence proceeds, the hedger cuts all twigs that have a straggling appearance, with the bill, towards the fence, to give a neatness and finish to the work. This sort of dead-hedge may be placed behind the thorns, much nearer than a paling, as from the breadth of its top, and the sharpness of its spines, no beast can, with impunity, reach over it to bite the twigs of the young hedge."

HEDGE-BILL. See HEDGE.

HEDGE-BIRDS. Birds which frequent hedges, and aro more or less accused of injuring farm crops. Hedges are very generally regarded in France and other parts of Continental Europe as far more advantageous to birds than to farmers, and are therefore denounced as a display of British folly; and even in many parts of Britain, they are sometimes viewed as rather doubtful benefits,—averting evil by sheltering from winds, but inflicting it by affording harbourage to birds. But though some hedge-birds undoubtedly prey upon farm crops, others do very little harm to them, and many do none whatever; and the really destructive ought, in common sense, to be distinguished from the harmless. "It would be as preposterous," remarks a periodical writer, "to accuse the wrens and redbreasts about a garden of feeding on the flowers or the pot-herbs, —or the lapwings or cuckoos on a farm, of grubbing up the young wheat or devouring the seed of newly sown barley, merely because they are found there,—as it would be to accuse a hare of hunting and worrying sheep, or a fox of stealing the nest-straw of the poultry-house for a similar reason. Yet are accusations equally erroneous very commonly made by farmers and gardeners, very well informed in other respects, but unacquainted with their habits and peculiar food, against the wild birds found in fields and gardens." Birds, indeed, have a far different relation to the fruit-garden and to the orchard than to the farm; and some are pests to the former which do little or no injury to the latter; but, in the aggregate, they are quite unduly accused in reference to fruit-gardens, and enormously so in reference to farms. We shall, in this article, take a brief view of hedge-birds in their relations to farm crops; and shall consider them in three classes,—non-destructive, partially destructive, and wholly destructive; and as most of them are separately described in articles of their own, we must here speak only of their food and of their places of resort.

Non-Destructive Hedge-Birds.—The golden-crested wren, *Regulus cristatus*, feeds exclusively on insects. It chiefly frequents cedars, spruce-firs, and other evergreen trees and shrubs; but it may frequently be seen flitting about hedges, espaliers, and rosaries; and it is liable to be denounced by an ignorant gardener as a spoliator of the blossoms of his wall-trees and his shrubberies; but it really does him material service, and employs itself in picking up every aphis and bud-weevil which it can find.—The wood-wren, *Sylvia sibilatrix*, the chiff-chaff, *Sylvia loquax*, and the hay-bird or willow-wren, *Sylvia fitis*, feed on aphides, larvæ, and small flies; and when plentiful, they do the farmer great service by thinning, on their first appearance, wheat-flies, blue-dolphins, hop-flies, and cabbage, turnip, bean, and pea aphides. Yet some farmers ignorantly denounce these useful birds; and many gardeners regard them with bitter prejudice and strong dislike. The hay-bird, in particular, is opprobriously called, in some parts of England, the cherry-chopper; but though often seen on cherry-trees, picking among the fruit, it does no harm to the cherries, but is wholly employed in eating up the destructive cherry aphis. The wood-wren principally frequents tall trees in hedge-rows, and other tall trees in their neighbourhood; and the hay-bird frequents small coppices, copsewood hedges, shrubberies, bushy gardens, and strawberry plantations. "The hay-bird," says Mr. Knapp, "comes in company with his travelling friends, not as a partaker of their plunder, appearing never to abandon his appetite for insect food. The species may change with the season; but still it is animal. He glides about our rows of pease, peeps under the leaves of fruit-trees for aphides and moths, continuing this harmless pursuit until the cold mornings of autumn drive him to milder regions."

The nightingale, *Motacilla luscinia*—the most charming song-bird of Britain, but occurring neither in Scotland, nor Ireland, nor North Wales, nor Cornwall, nor Devonshire, nor further north in England than Yorkshire—may be taught to eat berries, and perhaps helps itself occasionally, in its wild state, to a few currants; but it naturally feeds on insects, and always does the gardener important service by devouring grubs, caterpillars, beetles, moths, and butterflies. It frequents shrubby gardens, bramble-thickets, hedges, shrub-thickets, and coppices; and it so dexterously and deeply conceals its nest that many persons spend their lives among hedges and thickets where nightingales abound without once seeing a nightingale's nest.

The yellow wagtail, *Motacilla flava*, and other species bearing the popular name of wagtails, feed wholly on insects, particularly gnats, midges, and other tormentors of cattle. They even pounce close on the bodies of cattle in the fields, going under their belly and close to their nose, eating the flies which settle on their limbs, and probably finding worms and grubs which are roused by the trampling of their feet; and they also follow the plough to pick up the grubs and wireworms which are turned up in the furrows,—and they thus do good to both the stock and the crops of the farmer. These birds may be observed in corn-fields as often as most species; but they run about drains and furrows more commonly than about hedges.—The wheat-ear, *Saxicola œnanthe*, feeds on field-infesting insects, serves the farmer without eating any portion of his crops, and makes its nest in heaps of small boulders, and in similar situations about fields.—The stone-chat, *Motacilla rubecula*, has similar habits to the wheat-ear; and indeed gives its name, or at least the equivalent one of "stane-chat," to the latter bird throughout Scotland. It feeds on insects and slugs; and builds near the ground in the woods.

The tree-pippit or titlark, *Anthus arboreus*, is a very common hedge-bird, and feeds exclusively on insects. The meadow-pippit, *Anthus pratensis*,—called in Scotland the titling or moss-cheeper—may also be seen on hedges in the vicinity of moors, but prefers to run among the coarse grasses or upon the open heath. When the pippits prepare in autumn for their annual emigration, they abound in market-gardens and cultivated fields, particularly on the southern sea-board of England; but they leave all fruits and seeds untouched, and are wholly employed in picking up the autumnal hatches of grubs and caterpillars or such smaller flies and beetles as can be found among the herbage.—The common cuckoo, *Cuculus canorus*—well-known to select the chats, wagtails, titlarks, and hedge-sparrows as step-mothers for the hatching of its brood—also feeds entirely on insects. It alights on hedges and trees, but is so shy and alert as to be very rarely seen sitting upon them; but it may frequently be seen on the wing, though not without being readily mistaken for the kestril or the sparrow-hawk.

The common fly-catcher, *Muscicapa griseola*, is one of the most thoroughly insect-eating hedge-birds. But instead of keeping up a continuous flight like the swallow or the bat, he stands perched on a stake in the hedge, on the top of a gate-post, on a tall stick in the middle of a grass plot, on the projecting stone of a building, or on the naked spray or dead branch of a tree, and darts forth from time to time to catch a fly in the air, and returns to his station to swallow it, capturing one moment, resting the next, and continuing active throughout the greater part of a summer's day.—The flayer, butcher-bird, or

Jack Baker, *Lanius collurio*, feeds principally on flies and beetles, and is particularly fond of the breeze-flies which torment cattle; it feeds sometimes on wasps and bees, and may occasionally make a little inroad upon an apiary; and when hungry and ill-provided, it attacks field-mice, lizards, and small birds, and transfixes them, as it does also humble bees, on a thorn, and tears them in pieces.—Other hedge-birds might be named, which devour neither buds, seeds, nor fruits, and which feed either wholly or chiefly on insects, and therefore confer service on the farmer,—particularly the night-jar, the sedge-bird, the wry-neck, the creeper, and the bottle-tit.

Partially Destructive Hedge-Birds.—The hedge-sparrow or dunnock, *Accentor modularis*, occasionally eats almost any nutritious substance which comes in its way, yet, by the very form of its bill, is decidedly an insect-eating bird. "When wild," says Bechstein, "the great varieties of things which serve it for food prevent its ever being at a loss throughout the year. It is equally fond of small insects, and worms, and small seeds. In spring, it feeds on flies, caterpillars, grubs, and maggots, which it seeks for in the hedges, bushes, and in the earth; in summer, it feeds chiefly on caterpillars; in autumn, on seeds of all kinds, and elder-berries; and in winter, when the snow has covered all seeds, it has recourse to insects hid in the creeks and crevices of walls and trees." It probably does incomparably more good by destroying noxious insects than harm by eating seeds and fruits; and though generally regarded by both farmer and gardener as a great destroyer, it really levies but very slight contributions, even in autumn, upon any useful vegetation. It occasionally eats the farmer's oats and the gardener's currants, yet never when it can procure insects or wild berries; and in winter, when it abounds in gardens and is often thought to be very mischievous, it delights to pick up hybernating gnats and beetles, and rarely does worse than feed upon such small seeds as those of pimpernel, speedwell, lychnis, and sweet-william.

The common or European wren, *Troglodytes vulgaris*, feeds occasionally on elder berries and small seeds, but principally on gnats and small beetles. It frequents hedges, farm-yards, walls, and piles of wood, flits hither and thither among the branches of free-growing or neglected hedges, and delights in such spreading and low-growing branches of trees as overhang water, and afford it opportunities of catching gnats and other night-moving aquatic insects.—The red-breast or robin, *Erythaca rubecula*, feeds its young in a great degree upon fruit; and itself occasionally eats fruit in summer, and vegetable substances in winter; yet, as is fully apparent from its ungregarious habits, it is naturally and predominantly an insectivorous bird.—The redstart, *Phœnicurus inticulla*, eats both currants and elder berries, but is not so fond of them as of insects and worms; it usually feeds its young with such caterpillars or flies as it can find in the bushes of the garden; and though it carries off a few currants for its food, it saves far more by devouring the leaf-rolling caterpillars which prey upon the currant-plants. It is more a garden-bird than the redbreast, and very generally builds its nest in the hole of a wall.

The tits or titmice, *Pari*, eat almost all kinds of food, but upon the whole have a preference for insects; they are exceedingly active, and continually flit and climb from branch to branch, and suspend themselves, in all sorts of positions, from the twigs; and they tear up such seeds as they feed upon, devour all insects which come in their way, and even attack and kill any small birds which they find in a feeble or sickly condition. The tomtit or blue-headed titmouse, in particular—*Parus cœruleus*, called in Scotland the blue whaup—eats almost any kind of nutritious substance, and picks up a livelihood in situations where scarcely any other bird could find food. His small black bill, as hard as horn, and as sharp as a broad awl, speedily breaks up the hard wing-cases of beetles, or chips open the envelopes of chrysalides and pupæ, or penetrates the bud-shielded retreat or the bark-covered abode of minute insects which prey upon the embryo-blossoms or suck the interior juices of shrubs and trees. Tomtits have long been generally denounced as mischievous birds, and in some districts are systematically destroyed under the instigation of parish rewards, as if they were public pests; yet except for eating a few garden pease, and seeds of sunflower, hemp, and some other large plants, they are quite harmless or positively and highly beneficial. They penetrate buds and bark, not to feed upon the vegetable tissues themselves, but to devour the minute insects which lie ensconced in them, and which, if not removed, would destroy them. "The unwearied activity and perseverance of the tomtits, by visiting and unworming an incalculable number of wormed-buds, must therefore prove very beneficial in gardens and orchards, destroying so many latent pests that no human penetration could discover. Equally beneficial are the services of this bird in discovering and devouring the pupæ and chrysalides in crevices and chinks of the bark of trees, for nearly all such found in these situations are from caterpillars which have fed on the leaves, and of course would give origin to similar caterpillars, were they permitted to undergo their transformations. In consequence of their eating animal food, and having harder bills than the redbreast and the dunnock, the tomtits often procure a meal from the bits of meat or sinew left on bones, though they prefer, when they can get it, any remains of the marrow, and next to that they like suet, and will not refuse lard or a bit of fat bacon. They will even try to loosen the teeth of a sheep's jaw to see what they can find in the socket; and, for the sake of dainty bits of fat, will venture with little fear up to the very door of a butcher's shop." The great titmouse, *Parus major*, does more service in the destruction of lurking grubs and beetles than even the tomtit; and both this species, and the cole-tit and the marsh-tit, *P. ater*, and *P. palustris*, abundantly compensate all their spoliation of seeds by the havoc they make upon noxious insects; and though all, like the tomtit, are fond and frequent visitors of the orchard and the garden in autumn and winter, they there do little or no injury.

The blackcap, *Carruca atricapilla*, feeds partly on insects, but principally on small garden fruit, and is so voracious a feeder as to eat nearly his own weight in the course of a day. He prefers the currant and the raspberry, and seldom touches the cherry or the strawberry. Yet seldom more than one pair of blackcaps resort to any one garden; and they pay well for their inroads upon fruit, by the surpassing richness of their song, and by their occasional ravages among insects.—The babillard, *Carruca garrula*, is much fonder of insects than the blackcap, and is less nice in its taste and not so voracious in its appetite, and lives more in gardens and orchards, but does not occasion so much damage. It frequents fruit-enclosures and hedge-rows with high elm-trees, and delights to skip from tree to tree and among the higher branches.—The pettychap, fauvette, or garden warbler, *Sylvia hortensis*, attacks and swallows garden spiders, full-grown cabbage caterpillars, and other large insects, and can perform the feat of swallowing a pretty large grape without breaking the skin. It destroys a considerable quantity of garden produce, but probably saves more by destroying caterpillars.—The white throat, *Sylvia cinerea*, has a bad name among both gardeners and farmers, but does not deserve it; for though it occasionally eats a few currants or tastes a ripe jargonel pear, it is guiltless of the habit often charged upon it of eating pease and feasting on the dainties of the garden, and it confers great benefit by destroying insects and cleaning hedges. It frequents lanes, hedges, bramble-thickets, and nettle-wastes, searches diligently for various kinds of larvæ, and protects hedges from much of the deformity which the small hawthorn ermine and other caterpillars inflict by devouring and webbing over their foliage.

The missel-thrush, *Turdus viscivorus*, can live in wild and solitary places, but often gives such preference to the garden and the orchard as to be truly a hedge-bird; and though it does considerable harm by eating cherries and other fruit, it also does much good by devouring great numbers of grubs and caterpillars, and by driving away all jays, pigeons, and other spoliators of valuable seeds. "It is," says Knapp, "a wild and wary bird, keeping generally in open fields and commons, heaths and unfrequented places, feeding upon worms and insects. In severe weather, it approaches our plantations and shrubberies to feed on the berry of the mistletoe, the ivy, or the scarlet fruit of the holly or the yew; and should the redwing or the fieldfare presume to partake of these with it, we are sure to hear its voice in clattering and contention with the intruders, until it drives them from the place."

The song-thrush or mavis, *Turdus musicus*, is a voracious fruit-eater, and makes great havoc among cherries, currants, gooseberries, and exposed grapes; and, on the Continent, is so very destructive a grape-eater as to be popularly called the vine-thrush; but it does good service to the gardener by destroying slugs and the two very mischievous species of shell-snails, *Helix hortensis* and *Helix aspersa*. In the morning twilight, when the grey snail cannot yet be discovered by the human eye, the song-thrush inspects every inch of ground in the garden to detect and destroy it; and in winter, this bird passes a great portion of its time at the bottom of ditches. searching for the smaller kinds of snails, that it may draw them out from their deepest retreats, and dash their shells to pieces on a stone.

The blackbird, *Merula vulgaris*, is quite as great a fruit-eater as the song-thrush, but is not so plentiful, and makes considerable compensation by devouring grubs and caterpillars.—The ring-blackbird, *Merula torquata*, called in Scotland the stirling, does harm only among the fruit-shrubs of the gardens of moorland farmeries.—The fieldfare and the redwing, *Turdus pilaris* and *Turdus iliacus*, though mischievous enough in the fruiteries of countries farther north, do no further harm in Britain than to eat haws and such other wild fruits as they can find in winter.—The starling, *Sturnus vulgaris*, greedily eats cherries, currants, gooseberries, and exposed grapes in gardens a little removed from human dwellings; but is too timid to commit depredations in the immediate vicinity of man; and it confers benefit by devouring snails, grubs, and caterpillars.

Wholly Destructive Hedge-Birds.—The goldfinch, *Fringilla carduelis*, makes its home on an espalier in the garden or an apple-tree in the orchard, and feeds on the seeds of plants of the composite order, and freely plunders such seeds from both the garden and the field. But we rank it and some other graminivorous birds as wholly destructive, not because they do no service to the cultivator, but merely because they do not destroy insects. The goldfinch, in particular, might almost as well claim to be but a partially destructive bird as the tits and the thrushes; for it eats up the seeds and checks the diffusion of some of the chief vegetable pests of rich cultivated lands, particularly of groundsel, coltsfoot, dandelion, nipplewort, and thistles.

The green-bird or green-linnet, *Loxia chloris*, bites off the heads of seeding lettuces and seeding cabbages,—eats almost all sorts of ripe or ripening seeds, particularly those of flax, and of most of the cultivated brassicas,—makes free with ripening oats and wheat in the vicinity of hedges and woods,—picks up a considerable or even large portion of the grains of sown wheat throughout patches of a field,—and commits great depredations in the disbudding of currant-bushes, apple-trees, lilacs, and almost all other sorts of fruiting and flowering ligneous plants. It is therefore an indiscriminate pest; and, in consequence of being a very common frequenter of hedges in most parts of the kingdom, it is exceedingly destructive. It occasionally confers a little advantage by eating up the seeds of groundsel, chickweed, and other common weeds; but it seldom if ever touches these when it can obtain the seeds of cultivated plants. The only protections from it are bird-lime and the gun, and covering up with the net.

The yellow-hammer, yoyt, yellow-yoyt, or yoldren, *Emberiza citrinella*, is much more abundant, and perhaps considerably more destructive, than the green-bird; and it is everywhere disliked, and in some places superstitiously abhorred, and in a few called "the Devil's bird," probably on account of its destructive habits. It feeds its young entirely on caterpillars and imago-insects, and so far does good service; but, in its mature state, it feeds only on seeds, and has a great preference for some of the most valuable ones on the farm. Yellow-hammers may be seen very busily picking up the grain of oats, spring-wheat, and other vernal-sown cereals, from the moment they are sown till the period of their sprouting or brairding; they combine with sparrows, buntings, and other plunderers, about the time of the ripening of the corn-crops, to make great devastation upon the corn-ears along the skirts of the fields immediately flanking the hedges; they afterwards subsist by frequenting and gleaning the stubbles; and after the winter-wheat is sown, they live for some weeks on such grains of it as are not buried beyond their reach. —The cirl-bunting, *Emberiza cirlus*, resembles the yellow-hammer both in appearance and in habits, but is a comparatively rare bird.—The reed-bunting or black bonnet, *Emberiza shœniculus*, frequents low bushes on stock-farms and by the side of moors; and commits great depredations upon patches of oats in bleak and upland situations, yet feeds principally on the seeds of the wild phænogams of the moors and marshes.

The corn-bunting or stocking-weaver, *Emberiza miliaria*, frequents trees and hedges by the side of meadows, and perches itself for hours together on the summit of tall bushes or low trees in the immediate vicinity of farmeries; and it feeds wholly on the seeds of cultivated crops, and is a great destroyer. In spring, it devours considerable quantities of newly-sown seed-corn; in early autumn, it plunders the ripening seeds of beans, pease, oats, wheat, and other field crops; in late autumn or early winter, it picks up the grain of winter wheat; and during winter, it feeds on such seeds as it can find on stubble lands, and on whatever plunder it can seize within the stack-yard. "It could hardly be supposed," says Knapp, "that this bird, not larger than a lark, is capable of doing serious injury; yet I this morning witnessed a rick of barley, standing on a detached field, entirely stripped of its thatching, which this bunting effected by seizing the end of the straw and deliberately drawing it out, to search for any grain the ear might yet contain; the base of the rick being entirely surrounded by the straw, one end resting on the ground and the other against the snow, as it slid down from the summit, and regularly placed as if by the hand; and so completely was the thatching pulled off, that the immediate removal of the corn became necessary. The sparrow and other birds burrow into the stack and pilfer the corn; but the deliberate operation of unroofing the edifice appears to be the habit of this bunting alone."

The sky-lark or laverock, *Alauda arvensis*, though not a hedge-bird, and unfitted by the structure of its feet to perch on bushes, may be mentioned in this place as a bird of the same habits as the corn-bunting, but as much more numerous, and as therefore committing far greater plunder both upon newly-sown corn and upon ripening field crops.—The wood-lark, *Alauda arborea*, frequents heaths, commons, and hedges; partially feeds on ripening grain in the vicinity of woods, coppices, and heathy thickets; and occasionally takes a dinner out of the seed-corn of spring oats and winter wheat on farms of the mixed husbandry.

The linnet or lintie, *Fringilla cannabina*, *Linota cannabina*, or *Linaria cannabina*, is in the rare predicament of perpetrating vastly more mischief than is commonly ascribed to it. It sometimes frequents remote private gardens or large market-gardens, strips the heads of seeding lettuces, and almost rivals the sparrow and the chaffinch in plundering newly-sown seed-beds, particularly those of radishes, turnips, and cabbages; it commits considerable depredations upon seeding field turnip-plants and upon newly-sown field turnip-grounds; it feeds on standing corn from the commencement of its whitening till it is carted from the field; and it sometimes makes so great a spoliation of newly-sown winter wheat, that the braird is scarcely worth preserving; and when it perpetrates this last and worst kind of injury, the farmer, in the great majority of instances, does not once suspect the real depredator, but falsely accuses wire-worms, grubs, or rooks. A scare-crow frightens the linnet from a garden; but boys require to be employed at the most important seasons, to frighten it from fields.

The chaffinch or silfa, *Fringilla spiza*, though generally a great favourite with bird-fanciers, is a very destructive little creature. It frequents bushes and trees in all parts of the country; but is most partial to hedges and orchards. It feeds its young with caterpillars and insects, and perhaps now and then eats some itself, so that it does some good; but in its usual habits after maturity, it feeds on a great variety of small seeds, and is both an exceedingly miscellaneous and a very expert depredator. It peculiarly relishes the seeds of hemp, rape, and beech; it readily eats the hips of roses, and the seeds of the mountain-ash, the hawthorn, the burdock and the poppy; it eats the grains of wheat and oats, and exercises great expertness in shelling them; it makes such havoc upon the tree and shrub seed-beds of nursery-grounds, particularly upon those of the mountain-ash, the hawthorn, the beech, the fir, and many others, that the nurseryman who does not know its habits, or has not observed its depredations, may very probably pronounce the seeds which he sowed to have been bad; it makes sad havoc upon either spring-sown or autumn-sown beds of lettuces, radishes, cauliflowers, broccoli, cabbages, and turnips; it even nips off the seed-leaves of these plants as soon as they spring up and exfoliate; and it sometimes disfigures and maltreats the flower-garden in spring and early summer, by tearing up or stripping off the flowers of polyanthus and other beauties of the parterre, probably in search of the immature seeds in the ovaries.

The bullfinch, *Pyrrhula vulgaris*, does great mischief, not only in eating some kinds of seeds, but in tearing open and destroying many kinds of buds. In severe snowy weather, it feeds chiefly on the hips of wild roses; and afterward, it frequents orchards and gardens, and feeds there upon the blossom-buds of shrubs and trees. It is somewhat dainty in its choice, and seldom feeds upon two kinds at the same time. It usually begins with the buds of the earliest and largest gooseberries, and sometimes completely destroys the gooseberry crop; it next attacks the buds of cherries, and frequently subjects them to utter havoc; it next attacks the buds of plums, but does not touch those of peaches or apricots; and it then betakes itself to the sloe-trees in the hedges or by the side of brooks. But it sometimes is far from restricting its ravages to fruit-plants, but devours thousands of the blossom-buds of flowering shrubs, particularly of the lilac, the Tartarian honeysuckle, and the Japan corchorus; and in very severe weather, it sometimes feeds on the leaves of carnations; and in districts which abound in plantations of fir, it eats fir-cones, and loves to build its nest on the broad platform of a silver-fir branch. The ground beneath orchard-trees and garden-shrubs on which the bullfinch has been feeding, may, in many cases, be seen strewed with the envelopes of the buds, which it had shelled off in the same manner as the husks of seeds.

The sparrow or house-sparrow, *Passer domesticus*, is the most numerous and mischievous of all the hedge-birds. Yet many writers class it with but partially destructive birds, and even contend that it does more good than harm. Mr. Jesse, for example, says, "With the exception of feeding on corn and pease, which may be in a great measure prevented by setting boys to watch during the short space the corn is ripe, I believe sparrows are of the greatest utility to the farmer, devouring myriads of insects, which would otherwise do him infinite injury; this is particularly the case when they have young ones,—all of which are fed with insects and caterpillars; and I feel convinced that they would not have been so generally distributed, over most parts of the world, had they not been intended for some useful purpose." But are not the very insects which they are alleged to destroy, and many other insects of similar habits, and many small creatures of other classes than the insects, and many of the most troublesome weeds, and many of the chemical actions of natural vegetation—are not all these "generally distributed over most parts of the world," and at the same time very mischievous in their habits, and yet both appointed and admirably adapted to serve eminently "useful purposes?" A creature which man calls noxious, just as certainly as one which he calls beneficial, is perfectly fitted and assuredly ordained by his beneficent Creator to subserve his best interests, not only for the future state of existence, but also for the present world. Sparrows do good to the farmer in the same way as grubs and wire-worms and weevils and aphides and animalcules and fungi; they teach him his dependence, and force him to employ his wits, and are constant and exciting occasions of his becoming at once humble, intelligent, and wise. "Small as these birds appear to be," says a practical writer, "their consumption of grain in the fields, both in seed-time and harvest, is very great; they very often take almost every grain all round the field to the breadth of 8 or 10 feet, and frequently to as many yards; while their destruction of the roofs of thatched buildings is perceptible to every one." "Persons who had kept them in cages," says Buffon, "assured me that a single pair of sparrows consume nearly 20 pounds weight of corn every year; and taking this and their prodigious numbers into consideration, what enormous destruction must they make over our fields! For though they feed their young with insects, they chiefly subsist on the best grain. They follow the sower in seed-time, and the reaper in harvest; they attend the thrashers at the barns, and the poulterer when he scatters grain to his fowls; they visit the pigeon-houses, and pierce the craw of the young pigeons to extract their food." Sparrows also disbud garden shrubs and trees, deflorate pinks, carnations, and picotees, eat great quantities of the sown seeds of spinach, lettuce, radish, turnip, cabbage, and other kitchen-garden plants; and destroy the braird or seed-leaves of both field and garden plants, to an excessive degree, and sometimes in circumstances where the evil is erroneously charged upon snails, slugs, and caterpillars. But the general habits of these exceedingly destructive birds, as well as the best known methods of keeping them in check, will be noticed in the article SPARROW.—The tree-sparrow, *Passer montanus*, abounds in a few localities in Britain, but is by no means generally common; it frequents gardens, orchards, hedges, and tree-environed fields; it resembles the linnet more than the house-sparrow in its destructive habits; and it is mischievous principally in seed-time and in harvest.

HEDGE-GARLIC,—botanically *Alliaria*. A small genus of hardy, evergreen, herbaceous plants, of the umbelliferous order. The officinal species, *A. officinalis*, grows wild on the hedge-banks of some parts of Britain. Its stem is usually about a yard high; and its flowers are white-coloured, and bloom in May. It was regarded by the older botanists as a hedge-mustard, and was called by Linnæus *Erysimum alliaria*.

HEDGEHOG. A species of quadrupeds distinguished by having the body covered with spines instead of hair. The skin of the back is provided with muscles, which enable the animal to roll itself up in the form of a ball. The tail is very short, and the feet furnished with five toes. There appear to be but two species well ascertained; the third, given by Desmarest, being founded on a short description by Seba, which may possibly belong to an animal of another genus. The best known is the common hedgehog, *E. Europæus*, a native of most of the temperate parts of Europe and Asia. This species has a long nose, the nostrils bordered on each side by a loose flap; the ears are short, rounded, naked, and dusky; the upper part of the face, sides and rump covered with strong, coarse hair, of a yellowish ash-colour, the back with sharp, strong spines, of a whitish tint, with a bar of black through their middle. They are usually about 10 inches long, the tail about one. Their usual residence is in small thickets, and they feed on fallen fruits, roots, and insects; they are also fond of flesh, either raw or roasted. One of the most interesting facts in the natural history of the hedgehog is that announced in 1831, by M. Lenz, and which is now confirmed by Professor Buckland. That is, that the most violent animal poisons have no effect upon it—a fact which renders it of peculiar value in forests, where it appears to destroy a great number of noxious reptiles. M. Lenz says that he had in his house a female hedgehog, which he had kept in a large box, and which soon became very mild and familiar. He often put into the box some adders, which it attacked with avidity, seizing them indifferently by the head, the body, or the legs, and did not appear alarmed or embarrassed when they coiled themselves around its body. On one occasion M. Lenz witnessed a fight between the hedgehog and the viper. When the hedgehog came near and smelled the snake, for in those animals the sense of sight is very obtuse, she seized it by the head, and held it fast between her teeth, but without appearing to do much harm; for having disengaged its head, it assumed a furious and menacing attitude, and hissing vehemently, inflicted several severe bites on the hedgehog. The little animal, however, did not recoil from the bites of the viper, or indeed seem to care much about them. At last, when the reptile was fatigued by its efforts, she again seized it by the head, which she ground between her teeth, compressing the fangs and glands of poison, and then devoured every part of the body. M. Lenz says that battles of this sort occurred in the presence of many persons; and sometimes the hedgehog has received eight or ten wounds on the ears, the snout, and even on the tongue, without appearing to experience any of the ordinary symptoms produced by the venom of the viper. Neither herself nor the young she was suckling seemed to suffer from it. This observation agrees with that of Palles, who assures us that the hedgehog can eat about 100 cantharides without experiencing any of the effects which the insect taken inwardly produces on men, dogs, and cats. A German physician, who made the hedgehog a peculiar object of study, gave it a strong dose of prussic acid, of arsenic, of opium, and of corrosive sublimate, none of which did it any harm. The hedgehog in its natural state only feeds on pears, apples, and other fruit, when it can get nothing it likes better. Its ordinary food consists of worms, slugs, snails, adders, and sometimes rats and mice.

It has been asserted that these animals mount fruit-trees, and come down with apples, pears, &c., stuck upon their bristles. This is equally false with the imputation that they suck cows, and injure their udders. Mr. White observes that the manner in which they eat the roots of the plantain is very curious. With their upper mandible, which is much longer than the lower, they bore under the plant, and gnaw off the root upwards, leaving the tuft of leaves untouched. The hedgehog defends himself from the attacks of other animals by rolling himself up, and thus exposing no part of his body that is not furnished with a defence of spines. It may be rendered domestic to a certain degree, and has been employed in Europe to destroy cockroaches, which it pursues with avidity. In the winter, the hedgehog wraps itself up in a warm nest, composed of moss, dried hay and leaves, and remains torpid till the return of spring. The female produces four or five young at a birth, which soon become covered with prickles. These animals are sometimes used as food, and are said to be very delicate. The skin was formerly used for the purpose of napping cloths. The long-eared hedgehog, *E. auritus*, is smaller than the common, and is distinguished by the great size of its ears; in its manners, it is said to be similar to that species. The female produces twice each year, having six or seven young at a birth. This species inhabits from the northern part of the Caspian sea to Egypt.

HEDGE-HYSSOP,—botanically *Gratiola*. A genus of somewhat ornamental plants, of the figwort order. The officinal species, *Gratiola officinalis*, is a hardy, perennial-rooted herb. It grows wild in marshy grounds in the south of Europe, and was introduced nearly three centuries ago to Britain. Its root is fleshy, fibrous, and creeping; its stems are erect, cylindrical, and about a foot high; its leaves are opposite, sessile, lanceolate, smooth, nearly two inches long, and about half an inch broad; its flowers are axillary, solitary, tubular, with pale purple limb, and yellowish, red-streaked tube, and bloom from May till August; and its capsules are oval and many-seeded. This herb has a nauseously bitter taste, but is nearly odourless; it possesses purgative, diuretic, and emetic properties in small doses, and acts as a poison in large ones; and it figures among the materia medica of the Edinburgh Pharmacopœia, and possesses considerable celebrity for dropsical and scrofulous affections among the physicians of Germany, and is usually administered in powder or in aromatic infusion. —Two white-flowered and two yellow-flowered species, all parterre-plants, have been introduced from America; and about 30 other species are known.

HEDGE-KNIFE. See HEDGE.

HEDGE-MUSTARD,—botanically *Erysimum*. A genus of hardy plants, of the cruciferous order. Two species grow wild in Britain; and nearly 50 have been introduced from foreign countries, principally Siberia and Continental Europe. All, with the exception of one small evergreen undershrub, are either annuals or biennials; most are yellow-flowered; a few are ornamental; and the majority are interesting only to botanical collectors. Certain heating or even blistering properties, which distinguish them in common with many other cruciferæ, are alluded to in both the popular name hedge-mustard, and the botanical one erysimum. Upwards of a dozen of the species are regarded by some botanists as wallflowers; and three or four as brassicas.

The wallflower-like hedge-mustard, *E. cheiranthoides*, is an annual weed of the fields of some parts of Britain. Its stem is about 20 inches high; and its flowers are yellow, and bloom in July and August.—The hare's-ear hedge-mustard, *E. austriacum*—called by Jacquin *Brassica austriaca*—is an annual weed of some of the cliffs of England. Its stem is about a foot high; and its flowers are white, and bloom in June.—Perowski's hedge-mustard, *E. Perowskianum*, was introduced about 9 years ago from Russia, and is already in extensive cultivation among the pet annuals. Its stem is about two feet high; and its flowers are orange-coloured and fragrant, but do not entitle it to the consideration which caprice and fashion have given it.—The various-coloured hedge-mustard, *E. versicolor*—sometimes called the various-coloured wallflower—was introduced about 22 years ago from the Caucasian mountains. Its root is biennial; its stem is about a foot high; and its flowers bloom in May and June.—The most ornamental of the remaining species are Redowski's, the long-podded, the golden, the intermediate, the large-flowered, the strigose, the firm, the decumbent, the hill, the fine-leaved, the Rhœtian, and the two-coloured,—the first five undoubted hedge-mustards, and the others sometimes regarded as wallflowers.

HEDGE-MUSTARD,—botanically *Sisymbrium*. A genus of plants, of the cruciferous order. Three species grow wild in Britain; between 40 and 50 have been introduced from other countries; and nearly 20 more are known. Most of the introduced species are yellow-flowered, and hardy; all, except two or three, are either annuals or biennials; and scarcely any deserve a place in the garden.

The common or officinal hedge-mustard, *Sisymbrium officinale*—called by some botanists *Erysimum officinale*—is a very common annual weed of the banks, road-sides, and waste grounds of Britain. Its stem is erect, pubescent, and about 20 inches high; its branches are numerous, horizontal, cylindrical, leafy, and pubescent; its leaves are lobed, lyrate, unequally serrated, and of a dull green colour; its flowers grow in small, elongated, corymbose heads, are small and yellow, and bloom from May till July; and its silicles are subulate, and contain about six seeds in each cell. This herb was formerly used in pulmonary complaints, but has totally lost its medicinal reputation.

The broad hedge-mustard or London rocket, *Sisymbrium irio*, is an annual weed of walls and dry waste grounds in England, principally in the neighbourhood of London; and is the type of far the largest of six divisions of the genus. Its stem is about 20 inches high; its leaves are pinnate-lobed, runcinate, acute, quite smooth, and of a lighter green than those of the common species; its flowers are yellow, and bloom from May till August; and its silicles are cylindrical, and about two inches long, and contain an abundance of ovate and subtriquetrous seeds.—The other indigenous species is noticed in the brief article FLIXWEED.

HEDGE-NETTLE,—botanically *Stachys*. A genus of plants, principally hardy, herbaceous, and ornamental, of the labiate order. Four species grow wild in Britain; about 60 have been introduced from the south of Europe, the African and Asian shores of the Mediterranean, the Mediterranean Islands, North America, and other countries; and a few more are known. Six or seven are evergreen undershrubs; two or three are trailers; three or four are hardy annuals; and nearly all the rest are hardy perennial-rooted herbs. The popular name hedge-nettle alludes to the appearance of the foliage; and the botanical name stachys signifies a spike, and alludes to the habit of the flowers. All, except a very few, produce their flowers in whorls; and the greater number have their flowers of a purple colour. Some one, two, or more of the species are very commonly met with in the open border of flower-gardens.

The wood or wild hedge-nettle, *Stachys sylvatica*, is a perennial-rooted weed of the hedges of Britain. Its stem is about two feet high; its floral-whorls are six-flowered; and its flowers have a blood colour, and bloom in July and August.—The doubtful hedge-nettle, *Stachys ambigua*, is a perennial-rooted indigen of the lofty mountains of Britain. Its stem is about 20 inches high; its floral-whorls are six-flowered; and its flowers are purple-coloured, and bloom in June and July.—The German hedge-nettle, *Stachys germanica*, is a perennial-rooted weed of the fields of the chalk districts of England. Its stem is about a yard high; its floral-whorls are very numerously flowered; and its flowers have a purple colour, and bloom in July.—The marsh hedge-nettle, *Stachys palustris*, is a perennial-rooted indigen of marshy parts of British mountains; and shares with the genus sideritis the popular name of clown's all-heal. Its stem is about two feet high; its floral-whorls are ten-flowered; and its flowers are purple, and bloom in August. Two varieties of it, with respectively white and variegated flowers, occur in gardens.—One or more of these indigens had at one time some medicinal fame; but they have completely lost it.

HEDGE-PARSLEY,—botanically *Torilis*. A genus of hardy, annual plants, of the umbelliferous order. Three species—all with small flowers, rough umbels, and small bristly fruit—are weeds of Britain.—The anthriscus hedge-parsley, *Torilis anthriscus*, called by some botanists *Caucalis anthriscus*, grows wild about hedges. Its stem is nearly a yard high; and its flowers are red, and bloom in July and August.—The knotted hedge-parsley, *Torilis nodosa*, is a trailing weed of British corn-fields. Its stem is about two feet long; and its flowers are white, and bloom from May till July.—The troublesome hedge-parsley, *Torilis infesta*, called by some botanists *Caucalis arvensis*, also infests corn-fields. Its stem is about a foot high; and its flowers are yellow, and bloom in July and August.

HEDGER. See Hedge and Farm-Servants.

HEDGE-SPARROW,—scientifically *Accentor modularis*. A British hedge-bird, of the fauvette division of the passerinous order. It has a total length of rather more than 5½ inches. Its colour is brownish-fawn, spotted with black above, and slaty-ash below. It somewhat resembles the common or house-sparrow in colour, and in habits of feeding, but is very unlike it in many other characters. Its nest is built in the leafless hedge at a very early period of the year, and consists of roots, moss, and wool, lined with hair; and its eggs are 4 or 5 in number, and 9½ lines long, and have a fine, delicate, bluish-green colour. Its young ones, soon after being hatched, are, in many instances, thrown out by the cuckoo. The call-note and song of the hedge-sparrow have some resemblance to those of the common wren. The hedge-sparrow takes some seeds from the farmer, but also destroys noxious insects. See the article Hedge-Birds.

HEDWIGIA. An evergreen, balsamiferous, ornamental, tropical tree, of the terebinth family. It is specifically called *balsamifera;* and is a native of the West Indies; and has naturally a height of 40 or 50 feet; and was introduced about 27 years ago to the botanical collections of British hothouses.

HEDYCHIUM. A genus of ornamental, tropical, evergreen, herbaceous plants, of the scitamineous or ginger family. Nearly 30 species have been introduced to Britain, principally from India; and many of them possess great splendour, and make an imposing figure in the hothouse. The name hedychium is compounded of two words signifying "sweet" and "snow;" and alludes to the delicious fragrance and the exquisite purity of the flowers.

The coronal hedychium, or sweet-scented garland-flower, *H. coronarium*, grows wild in India, Malacca, and China, and was introduced to Britain near the end of last century. Its stem is 5 or 6 feet high; and its flowers have a snow-white colour and a surpassingly grateful fragrance, and bloom in constant succession, throughout July, August, September, and the greater part of October, at the top of the strongest shoots, from beneath the imbricated scales, composing a compact, squamose, oblong spike. This plant is often worn by the Hindoo ladies in their hair, and is employed in a symbolical manner by the Malays; and its flowers, either on the plant or in a bouquet, diffuse the most delightful odours which can possibly refresh the drawing-room.—The narrow-leaved hedychium, or red garland-flower, *H. angustifolium*, was introduced about 32 years ago from India. Its stem is also 5 or 6 feet high; and its flowers grow in fine large clusters of a foot in length, and bloom from July till September, and have a soft vermilion or scarlet colour, and diffuse a fragrance which is exceedingly delightful, yet much less so than that of the coronal species.—Among the other beautiful species, are *H. aurantiacum*, with orange-coloured flowers; *H. stenopetalum*, *gracile*, *thyrsiforme*, *acuminatum*, *maximum*, and *ellipticum*, with white flowers,—the first an early spring bloomer; *H. villosum*, with cream-coloured flowers; *H. carneum*, with pinkish or flesh-coloured flowers; *H. coccineum*, with scarlet flowers; and *H. spicatum*, *flavum*, *flavescens*, *heteromallum*, *Gardnerianum*, and *urophyllum*, with yellow flowers,—the last eminently fragrant.

HEDYPNOIS. A genus of yellow-flowered,

weedy, annual plants, of the succory division of the composite order. About a dozen species are known; and more than half have been introduced to Britain; but, in spite of their name, which signifies "sweet-breathing," they possess little interest.

HEDYSARUM. A genus of herbaceous plants, constituting the type of a tribe of the papilionaceous section of the leguminous order. The species of about 32 genera at present in Britain are assigned to this tribe; and the greater number of these are ranked as true hedysareæ, while the remainder are subrepresented by the genus coronilla and the genus alhagi. Many species which formerly belonged to the genus hedysarum are now distributed among no fewer than 18 other genera; but about 30 species at present in Britain still belong to the genus hedysarum as now constituted, and 9 or 10 more are known. The hedysarums are very nearly allied to the sainfoins,—the latter ranking among the most prominent of the true hedysareæ; but the hedysarums have celled, jointed-like, and two or more seeded pods. All the species in Britain are hardy exotics; and three of them are annuals, three biennials, one a shrub, and all the others perennial-rooted herbs.

The garland hedysarum, or French honeysuckle, *H. coronarium*, is a native of Italy, and was introduced to Britain near the close of the 16th century. Its root is biennial; its stem is usually about 4 feet high; and its flowers grow in massive spikes, and have a rich scarlet colour, and bloom in June and July. A white-flowered variety of it, *H. c. albiflorum*, seems to have been introduced about the same time as the normal plant; and is distinguished by its lesser height and by the whiteness of its flowers. This species has been long and generally known in Britain as a favourite beauty of the parterre; and is cultivated in the fields, in several parts of the South of Europe, as forage for horses and mules. It yields a very bulky herbage crop, and can either be used green or made into hay, and has the reputation of being very nutritious. It has been recommended for field culture in Britain; but it could be grown only on warm dry soils, in sheltered situations,—it is very subject to injury or destruction from spring frosts,—and it could yield only one good crop in two years, and would require to be thoroughly resown as quite a strict biennial.—The most handsome of the other species, and the worthiest of a place in the flower-garden, are *H. grandiflorum*, *alpinum*, *splendens*, *roseum*, *tauricum*, *consanguineum*, *obscurum*, *elongatum*, *caucasicum*, *cretaceum*, *candidum*, and *fruticosum*,—most with purple-coloured flowers and about 12 or 20 inches high, and the last a beautiful purple-flowered shrub, of 4 feet in height, blooming in June and July.

HEE-GRASS. The stubble of grass.

HEEL. See Foot.

HEIFER. A young female of the ox species. She bears the name of heifer till her fourth year; and she is thenceforth called a cow. See the articles Cow and Calf.

HEIRS. Young trees in coppices.

HEISTERIA. A small genus of tropical plants, of the olax order. The scarlet species, *H. coccinea*, is a small, evergreen, scarlet-flowered tree, naturally about 20 or 25 feet high; and it grows wild in the West Indies, and was introduced thence, about 25 years ago, to the hothouses of Britain.

HELENIUM. A genus of hardy, yellow-flowered, ornamental, herbaceous plants, of the sunflower division of the composite order. Eight or nine species have been introduced to Britain from various parts of North America; and one of these is an annual, one a biennial, and the others radical perennials. A species was introduced about 12 years ago from Siberia, which gave high promise, upon trials of it in Ayrshire, of becoming a very valuable forage plant. Its roots are perennial and fibrous, but do not strike deep into the soil; and its stem and leaves somewhat resemble those of the parsnip, but are much larger. It grows much more readily than clover, and may be cultivated in the same manner as lucern, and is sufficiently productive and luxuriant to be mown three or four times in the year. In a scorching season, when the grass in Ayrshire was generally in an exsiccated, embrowned, and almost destroyed condition, this plant, even though growing upon a poor sandy soil without any manure, yielded a cut to the scythe of between two and three feet in height. One plant can afford 20 ounces at a cutting; and an acre of plants would, at the same rate, afford, in the aggregate of three cuttings, an annual produce of from 12 to 14 tons. The plant is much relished by cows, and was found, in the Ayrshire experiments, to increase the quantity and improve the quality of both milk and butter; and in favourable situations, on good soils, and in ordinary years, it might probably yield a cutting in the early part of April.

HELIANTHEMUM. See Sun Rose.

HELIANTHUS. See Sunflower and Artichoke (Jerusalem).

HELICHRYSUM. A genus of ornamental plants, of the thistle division of the composite order. About 50 species—all exotics, and the greater number from the Cape of Good Hope—are cultivated in the gardens of Britain. A considerable proportion occupy a somewhat conspicuous place in many greenhouses; all have an arid habit, and produce the exsiccated and long-enduring kind of flowers which are popularly called everlastings; and the great majority were formerly regarded as gnaphaliums, and constitute a main part of the showy group to which that name is still sometimes popularly given. See the articles Everlasting and Gnaphalium. Five or six of the species are annuals or biennials; three or four are hardy perennial-rooted herbs; six or seven are half-tender evergreen herbs; and all the rest are evergreen undershrubs, requiring, with two or three exceptions, the heat of the greenhouse. The flowers of most have a golden yellow colour, and give the name helichrysum or "sunny-gold" to the whole genus; but those of 13 or 14 are white, and those of a few have some shade of red. The finest of the herbaceous species are *H. crispum*, *graveolens*, *cylindricum*, and *herbaceum;* and the finest of the subshrubby species are *H. fulgidum*, *microphyllum*, *acuminatum*, *arboreum*, *divaricatum*, *lasiocaulon*, *tephrodes*, and *grandiflorum*. One of the herbaceous species, *H. odoratissimum*, is gratefully fragrant.

HELICONIA. A genus of tropical, ornamental, evergreen, herbaceous plants, of the plantain-tree family. About a dozen species, varying in height from 3 to 25 feet, and carrying orange, scarlet, or yellow flowers, have been introduced, principally from South America, the West Indies, and Madagascar, to the hothouses of Britain. All are beautiful; and the Brazilian species, *H. brasiliensis*, a scarlet-flowered, autumnal-blooming plant of 8 or 9 feet in height, is magnificent.

HELICTERES. See Screw-Tree.

HELIOCARPUS. A small genus of tropical, ligneous, ornamental plants, of the lime-tree family. The American species, *H. americanus*, is a tall, purple-flowered, evergreen shrub, of from 15 to 20 feet in height; and was introduced to Britain, upwards of a century ago, from tropical America. The name heliocarpus signifies "sun-fruit," but alludes more to shape than to colour.

HELIOPSIS. A genus of hardy, herbaceous, yellow-flowered plants, of the sunflower division of the composite order. Five or six species have been introduced to Britain from various parts of America; and some of these, perennial-rooted, autumnal-blooming, and from 2 to 6 feet high, have a kind of ornamental character.

HELIOTROPE, or Turnsole,—botanically *Heliotropium*. A genus of ornamental plants, of the borage family. Between 20 and 30 species have been introduced to Britain from Southern Europe, Africa, India, and other parts of the world; and nearly 60 other species are known. About a dozen of the introduced species are evergreen undershrubs,—a few of them of a trailing habit; and the rest are either annuals or biennials. Most are white-flowered; but five or six have lilac or blue flowers. Some of the species are prominent and general favourites of the flower-garden,—and are very frequently planted out in summer-beds in the same manner as verbenas; but they are valued much more for their powerful fragrance, resembling the mixed odours of anise and caraway, than for their appearance. The undershrubs vary in height from ½ a foot to 4 or 5 feet; but most of the annuals and biennials have a height of only a few inches. The undershrubs are readily propagated from cuttings; and all thrive in a rich light soil. Numbers trail and intertwine, so as thoroughly and densely to cover a bed; and they are said to turn toward the sun, and hence have the names of turnsole and heliotrope.

HELLEBORE. A genus of herbaceous plants, of the ranunculus order. They resemble the true ranunculi; but the large green, whitish or purplish flowers of the different species give them a different aspect. Ten species are known, all natives of the northern parts of the eastern continent. These plants have a bitter and somewhat acrid taste, and a nauseous disagreeable odour. The well known winter aconite, formerly ranked as a hellebore, is now assigned to another genus. See the article Winter Aconite.

The green hellebore, *Helleborus viridis*, is a native of woods and thickets, on calcareous soils, in some parts of England. It commonly ranks as a kind of subevergreen, yet really loses its leaves in autumn. Its root is black and fleshy, has many long stout fibres, and possesses purgative and very acrid properties; its stem is cylindrical, erect, forked, and from 20 to 30 inches high; its leaves are nine-lobed, serrated, smooth, and bright green; its flowers are few, stalked, terminal, and drooping, and have green expanded petals, and bloom in March and April; and its fruit are short, wrinkled capsules. This plant has not the reputation of being medicinal, yet is far more virulent than many a native plant which does possess that reputation. It is sometimes cultivated in the flower-border for ornament; but it scarcely deserves the honour. Its roots are sometimes fraudulently substituted in commerce for those of black hellebore.

The stinking hellebore, bear's-foot, ox-heel, or bitterwort, *Helleborus fœtidus*, grows wild in woods, in thickets, under hedges, and in other shady situations, on calcareous soils, in Britain. It is taller, more branched, and far more truly an evergreen, than the preceding species. Its root is small and bent, and has many slender and dark-coloured fibres; its stem is cylindrical, strong, naked, complexly branched, and compressed toward the top; its leaves are large, seven or nine lobed, and pedate, each rising singly from the root on a channelled footstalk of about six inches in length; its leaflets are long, narrow, lanceolate, obscurely serrated, and deep lurid green; its flowers are numerous, peduncled, terminate, and pendent, and have a green colour, somewhat tinged with purple, and bloom from February till April; and its fruit are beaked capsules, containing round black seeds. This plant is used by both peasants and physicians as a medicine, but is far too active to be safely handled by the former, and requires to be treated with caution even under the prescriptions of the latter. Its fresh leaves and stipules have a fetid odour; and, when chewed, they are bitterish, biting, acrid, and excoriating. The roots are anthelmintic, but exceedingly and even dangerously virulent. The dried leaves are emetic and powerfully cathartic; and, though sometimes given in decoction as a vermifuge to children, ought to be regarded as rather a poison than a medicine. The proper remedies for an overdose of stinking hellebore, or for an accidental poisoning with it, are first an emetic, next copious mucilaginous drinks, and next vegetable acids.

Black hellebore, or the Christmas rose, *Helleborus niger*, is noticed in the article Christmas Rose. The root of this plant has long been well known in the practice of medicine, and has a place in all the British pharmacopœias. The radicle fibres, which are the parts used, are corrugated, and about as thick as straws, and from 4 to 12 inches long, and are externally deep brown black, and internally yellowish or white. Their odour is unpleasant; their taste is bitterish, acrid, and nauseous; and their action upon the tongue is acrimonious, burning, and benumbing. They seem to contain a volatile oil, a resinous gum, and some powerfully and perhaps peculiarly acrid principle; and they lose a portion of their acrimony by keeping. They are medicinally exhibited in the form of tincture and of extract; and they act in minute doses as an alterative, and in larger doses as an emmenagogue, a hydragogue, and a drastic cathartic, and are useful in cases of scabies, worms, dropsy, melancholy, and mania.—In veterinary medicine, black hellebore is used principally as a local application; and it acts as a very powerful stimulant, and has been found serviceable in fistulous affections of the poll and withers. An ointment formed with the powder of it and lard also serves as an excellent dressing of rowels and setons.

HELLEBORE (White). See Veratrum.

HELLEBORINE. See Epipactis and Cephalanthera.

HELLENIA. A small genus of ornamental, tropical, evergreen herbaceous plants, of the scitamineous or ginger family. Two white-flowered species, 3 or 4 feet high, have been introduced to Britain; and several more are known.

HELM. Straw prepared for thatching.

HELMET. A variety of pigeon.

HELMET-FLOWER. See Coryanthes and Aconite.

HELMINTHIA. A tall, yellow-flowered, annual, British weed, of the succory division of the composite order. It constitutes a genus of itself, and takes for its specific name *echioides*; but it was formerly classed as an ox-tongue, and called *Picris echioides*. It occurs on clay soil by the sides of hedges and on the borders of fields. Its root is tapering; its stem is solid, cylindrical, furrowed, leafy, and about 3 feet high; its lower leaves are lanceolate, its upper ones cordate and clasping, and all shining green, pubescent, and stinging; and its flowers have a bright golden colour, and are about an inch broad, and bloom in June and July.

HELONIAS. A small genus of ornamental herbaceous plants, of the melanthium family. Two white-flowered species and a purple-flowered one, all hardy herbaceous evergreens, from North America, have been thought worthy of a place in British flower-gardens. A number of species of five other genera are assigned by some botanists to the genus helonias.

HEMATIN. The colouring principle of logwood. It is easily obtained in a separate and crystalline form, by digesting the watery solution of logwood in alcohol, and allowing the liquid to evaporate slowly at the ordinary temperature of the atmosphere.

HEMATOSINE. The colouring principle of the blood. It cannot be separated from the blood without great difficulty; and, as eventually obtained, it possesses chemical properties akin to those of albumen, and exists, like that substance, in two very different states, soluble and insoluble. Dry soluble hematosine is black and lustrous in mass, red in thin pieces or in powder, and destitute of both taste and odour. See the article Blood. Hematosine, according to Michäelis, contains very nearly the same proportions of carbon, oxygen, hydrogen, and nitrogen as albumen and fibrin, but differs from these substances by containing a little iron.

HEMEROCALLIS. See Day-Lily.

HEMIONITIS. A genus of very beautiful tropical ferns, of the polypody tribe. A number of species formerly included in it are now assigned to gymnogramma and three other genera. See the article Gymnogramma. Only one species, *H. palmata*, is now regarded as a true hemionitis; and this possesses great elegance, and is 9 or 10 inches high, and was introduced to British hothouses upwards of 50 years ago, from the West Indies.

HEMLOCK,—botanically *Conium*. A genus of herbaceous plants, of the umbelliferous family. Some species which were formerly included in it are now assigned to five other genera; and of three species which still belong to it, and which occur in British collections, one is a biennial indigen of Britain, one is a medicinal white-flowered biennial of 6 or 8 feet in height, from Hungary, and one is an economical, tap-rooted, white-flowered perennial, of about two feet in height, from the tropical parts of South America.

The common or indigenous hemlock, *Conium maculatum*, is one of the most dangerous wild plants of Britain, but at the same time possesses valuable medicinal properties. It grows wild among rubbish, by road-sides, under hedges, and on waste grounds; and is particularly abundant in the vicinity of many towns and villages. Its root is fusiform, branching, fleshy, and whitish, and exudes a milky juice when cut; its stem is cylindrical, hollow, striated, smooth, shining, profusely spotted with purple, erect, and about 4 or 5 feet high, and remains long bleaching in the hedges throughout the months of autumn; its leaves stand upon channelled footstalks, proceeding from the joints of the stem, and are cut, smooth, and of a deep green above and a paler green below; its lower leaves have large sheathing petioles, and are upwards of a foot in length, shining, and repeatedly compound; its upper leaves are bipinnate; its leaflets are lanceolate, and emit a very fetid odour when bruised; its umbels are terminal and ten or twelve rayed, and have many-rayed umbellules, and an involucre of from three to seven lanceolate leaflets; its flowers are white and very small, and bloom in June and July; and its fruit is ovate, striated, and smooth, and becomes brownish when ripening.

Hemlock possesses a sufficient resemblance to anise, caraway, coriander, cumin, fennel, dill, angelica, and some other hardy, economical, umbelliferous plants to be readily mistaken for them by the ignorant; yet it may easily be distinguished, not only from them but from almost all other umbelliferous plants, by its large and spotted stem, by its dark and shining lower leaves, and by the disgusting odour which it emits when bruised,—somewhat similar to that of cat's urine. The leaves are the part used in medicine; and they must either be gathered when the plant is in flower, and carefully dried, for powder,—or gathered just before the plant flowers, and subjected to pressure, for extract. The dried leaves have a nauseous and slightly bitter taste, and a strong, heavy, narcotic smell. A peculiar alkaline principle, called coneine or cicutine, may be separated from the leaves by extraction in ether and evaporation, and seems to be the seat of the poisonous and medicinal power; and this principle has a green colour, and is insoluble in water, and produces the same effects as the leaves themselves, but in very small doses.

An over-dose of hemlock, or an accidental poisoning with it, produces sickness, vertigo, delirium, stupor, dilatation of the pupils, and convulsions, and is best combated first by administering doses of vinegar, and next by bleeding and purging. Cattle, when first turned out to pasture in spring, after being shut up during winter in the farm-yard, are liable to eat hemlock, and to be seriously damaged or even killed by it; but they somewhat obscurely show the symptoms of being poisoned, and either display a stupor which is mistaken for stomach-disease, or an excitement and a furor which are mistaken for madness.—Hemlock, as a medicine, acts principally as a powerful narcotic; and is used internally as an opiate and a sedative, and externally as an anodyne; and it often does good service, though chiefly as a palliative, in cases of scrofula, syphilis, glandular tumour, bad ulcer, cancer, scirrhus, pertussis, chronic rheumatism, and pneumonic cough. In veterinary practice, it is sometimes used for affections of the chest, but does not act so well as digitalis or veratrum.

HEMLOCK-SPRUCE. See Fir.

HEMLOCK (Water). See Cowbane and Water Hemlock.

HEMP,—botanically *Cannabis*. A genus of hardy, cultivated, annual plants, of the nettle family. It is one of the very few diœcious genera in cultivation,—producing the male flowers of a species on different plants from the female ones, and belonging to the Linnæan order *Diœcia Pentandria*. Its male flowers have a five-parted calyx; and its female flowers are five-leaved, and envelop a two-valved and nut-like seed, which opens at the sides.

Species.—The common hemp, *Cannabis sativa*, is supposed to have originally been introduced to Europe from India; and has long been known in Britain and in very many other civilized countries of the world. Its stem is erect, strong, and branching, and varies in height from 3 to 15 feet, according to soil, culture, and climate,—but in Britain is usually about 6 feet high; its leaves are lobed, and often quinquifid; and its flowers have a greenish-yellow colour, and bloom in June and July.—The Indian species or Indian tobacco, *Cannabis indica*, was introduced nearly 50 years ago from India. It has a height of about 20 inches, and carries green flowers in August and September.—The African hemp grows wild over many parts of Senegambia; and was specially introduced to the notice of the Highland Society, about 16 years ago, by Mr. Hunter, the Colonial Secretary to the settlements on the Gambia; and is said, in a brief notice of it in the Society's Transactions, to "promise to become an object of great importance." "It appears," says the notice, "to be the inner bark of some ligneous vegetable. The sample laid before the Society is upwards of 6 feet in length, the fibres running entire the whole length; the colour is yellowish-white, with a slight gloss; the fibres are straight, somewhat rigid, of less tenuity than those of flax, and rather inferior in tenacity, although possessed of considerable strength."—But the only species to which we shall refer in the subsequent sections of this article is the common one.

History.—Hemp has been cultivated, from time immemorial, in Bengal, and in other parts of the world; and it occurs in Persia, Egypt, China, Canada, Russia, Nova Scotia, and many other countries. It has very long been cultivated in the East, for the preparation of an intoxicating drink; and it has for ages been cultivated in many parts of Europe for the manufacture of cordage and of woven fabrics. It is grown, in amazing quantities, throughout the proper territories of Russia, and in those parts of Poland which are now within the Russian boundaries. "Amongst the Russian hemp imported into this country," said Kauffman long ago in his Dictionary of Merchandise, "the Riga deserves the preference, which, according to the quality, is divided into rhyne, out-shot, pass, and codilla hemp. Next follows the importation from St. Petersburg, consisting of clean out-shot, half clean, and codilla. There is also an inferior kind of hemp coming from Konigsberg, and divided into rhyne and schoken hemp. The Italian known in England by the name of Bologna hemp, is of very prime quality, but comes too dear for the consumption of the northern parts of Europe."

In the 14th and 15th centuries, hemp was cultivated on almost every farm in the Lowlands of Scotland; and so late as the former half of last century, a small quantity of it was grown in the rick-yard or some other part of every farm in the south-eastern districts of Scotland. "The servants and families of the farmers employed their winter-evenings round the fire in peeling it. In those days, the farmers had all their rude implements of husbandry made at home; where likewise they manufactured their whole 'graith' or harness, giving no employment whatever to the saddler or the collar-maker. All those things belonging to working-cattle, which are now made of leather, were then made of plaited hemp, such as breechings, back-bands, belly-bands, and the like. Even the traces for ploughs and carts, now universally of iron-chains, were then made of hempen ropes. The collars were composed of straw-ropes. Instead of bridles, hempen 'tethers,' often with wooden cheeks, served the farmers even for riding to church and market; and instead of saddles, they were contented with a kind of hempen bags, stuffed with straw, called 'sodds;' while a different shape of the same materials, called 'sunks,' served to preserve the horses' backs in carrying loads. Even the ridge chain, which supports the weight of a cart over the back of the shaft-horse in a cart, was then termed a 'rig-woody,' being composed of a 'withy' or twisted branch of a tree." But the improved state of civilization, the advanced condition of manufactures, and the great extent and enterprise of commerce, have completely upset all reasons for cultivating hemp for home consumption on farms, and even neutralized all the main reasons for cultivating it in rotations of crops in the fields, for the sale of its fibre and seeds to the merchant. It is now very rarely cultivated in Scotland; it is very seldom raised, in any considerable quantity, in even the flax-growing and most favourable districts of Ireland; and, as a British agricultural plant of anything like consequence, it occurs only, or at least chiefly, in some districts of Lincolnshire, Cambridgeshire, and Suffolk.

Culture.—The soils suitable for hemp may be either sandy, gravelly, clayey, or peaty; but they must be deep and fertile, and ought to contain a comparatively large proportion of humus. The land must be deeply ploughed, finely pulverized, and free from root-weeds. When hemp succeeds a grain crop, the land, in most instances, will require three ploughings; one of which ought to be given before winter, in order that the soil may be pulverized and decomposed by the action of air and frost and moisture. Hemp may very properly occur between grass and oats, in a rotation of successively fallow, wheat, grasses, hemp, and oats; or it may advantageously occur in any part of a rotation instead of flax; and as it is more cleaning than that crop, it is even preferable for succeeding oats or wheat on foul land. Hemp, like flax, is very scourging when grown for seeds, but quite non-exhausting when nothing of it is carried away from the field except the fibre; so that, in the former case, it can be profitably raised in succession on the same ground only with the aid of powerful manuring,—and in the latter, it may be luxuriantly grown for a series of years with very little manure or without any whatever. See the article FLAX.

The best season for sowing hemp, in the southern districts of England, is as soon as possible after the spring frosts have ceased; and in the north of England, the Lowlands of Scotland, and most of Ireland, about the beginning of May. The seed must be new and of good quality, and is known to be proper for sowing when it feels heavy in the hand, and has a bright and shining colour. The quantity varies from two to three bushels; and ought to be a minimum when a strong fibre, fit for the manufacture of very powerful ropes, is wanted, and a maximum when a slender fibre suitable for woven fabrics, and only a degree or two coarser than coarse flax, is required; but, in consequence of the crop being very liable to injury when thickly sown, the proper quantity may be stated, on the average, at something between 2 and 2½ bushels. The seed is generally sown broadcast, and lightly harrowed in; and as the plants grow very rapidly, and soon defy all attempts at weeding, they are peculiarly adapted to the broadcast method on any properly cleaned land; yet they may properly enough be raised in drills at small distances, and have even been very productive, on the Hebridean island of Islay, in drills at distances of about 32 inches. The diœcious nature of the plant, whenever seed is the object of the crop, renders it peculiarly necessary that the male plants, containing the fecundating pollen, and the female plants producing the seeds, and sometimes called frimble hemp, should grow in a state of thorough and equable intermixture. A crop on clean land, whether broadcast or in drills, requires nō attention between the time of sowing and that of pulling; but a crop on foul land, ought, at least once, to be carefully cleared from thistles, docks, and other strong weeds by means of the weed-hooks.

Harvesting.—Hemp, like flax, is taken out of the ground by pulling. When it is grown exclusively for sake of the fibre, the whole crop, without any distinction being made between the male and the female plants, is pulled when in flower. But when it is grown for sake of the seeds as well as of the fibre, the male plants are pulled about four or five weeks before the female plants; for as soon as the seeds begin to form upon the female plants, the male plants have fully accomplished all the purposes of fecundation, and are in a condition of perfect readiness to yield up a maximum of fibre,—and the female plants must remain four or five weeks longer to bring their seeds to maturity. The male plants carry numerous flowers, and are generally more delicate than the female plants; the numerous branches, which deflect from their stems, terminate in slender spikes; and the flowers, after expanding, hang pendently, in purplish-coloured clusters, from the leaves. The female plants, on the other hand, terminate in tufts; their leaves are somewhat large; and their seed is borne along the stem and hid among the foliage. The puller, therefore, easily distinguishes the male plants from the female ones; and, when taking up the former, he walks in the furrows, reaches across the half of each of the adjoining ridges, and pulls up and extricates the male plants with sufficient care to avoid inflicting any injury on the female plants. The crop of male plants is simply tied up in small parcels; but the crop of female ones is bound up in sheaves and set in stooks or against a wall till it dry in the same manner as a corn crop,—and it is then either thrashed on cloths in the field or taken home to the barn.

Dressing.—The watering, the grassing, and the bruising of hemp closely resemble the same operations on flax; but the duration of the watering is much shorter; and the male plants are watered and dressed before the female ones,—the former most commonly in the same season in which they are pulled, and the latter frequently stacked till the following spring or summer. Yet in some places, hemp, in technical phrase, is only "dew-ripened" or "dew-rotted;" while, in others, it is watered by steeping or "water-rotted." But the latter is, in all respects, the better method,—more expeditious in itself, and tending to shorten the period of grassing, and to lessen the severities and risk of breaking, scratching, and bleaching. The bundles or sheaves ought to be quite covered with the water of the pool, but must not be pressed against the bottom. Whenever the fibrous rind is sufficiently softened to be easily separable from "the boon," or heartstalk, the plants ought to be removed from the water,—and in warm weather, this will usually occur in the course of from four to six days; but, in consequence of the tendency of over-steeping to injure the texture and strength of the fibres, or absolutely to rot them, too little steeping is far safer than too much.

The grassing ought to be effected on a clean short sward, in a situation sheltered from high winds, and not liable to be flooded; and it extends through a period of from two to five weeks, according to the degree in which it has been watered, and to the state of the weather. The hemp is grassed till, after frequent trial, the fibrous part becomes easily separable; it ought, throughout the whole period, to be occasionally turned; and it should afterwards be allowed to lie for some time before being lifted. "Immediately after watering," says the General Report of Scotland, "it is dried, and then laid up to sweat for five or seven weeks, which causes it to work the more easily in the after parts of its preparation; and after being sufficiently grassed, the hemp is tied up again into sheaves or bundles as before, and again dried. For such hemp as is meant for ropes and other coarse articles of manufacture, the grassing process is seldom used in Russia or Poland.

In the breaking or bruising of hemp, care must be used not to cut or tear it, and therefore the handfuls of it must be frequently turned and shifted under the brake. The portion which breaks off in the process of bruising is technically called shorts, and is commonly estimated to be nearly half the value of the hemp.—A machine was, a considerable number of years ago, invented by Mr. Daniel Duff of Dundee, for freeing hemp-fibre from the glutinous matter which adheres to it, and rendering it somewhat similar in fineness to the fibre of flax; and another machine for the same purpose, was, a few years later, invented and patented by Mr. Alexander Shanks of Arbroath. The Dundee Courier thus notices the latter: "It is composed of two metal plates of a peculiar construction, supported by springs to modulate the compressure; and the hemp, in passing through these plates, undergoes a friction from the action of the plates, and after passing through several rollers, it leaves the machine free of the glutinous matter, and of a soft delicate fibre. When thus prepared, and heckled, it is equal to the finest flax, and may be spun and applied to the same purposes. The expense attending the process of preparation is very trifling, the machine being moved by steam power (which may be borrowed from any work where there is a steam engine), and a boy may attend and feed the machine in its operations. The machine is so contrived that the friction does not cut or injure the fibre, but simply removes the glutinous matter adhering to the hemp in its original state, and reduces it to a fine soft fibre." Many of the manufacturers of Forfarshire, however, early formed an opinion that hemp prepared by this machine lost as much in strength as it appeared to have gained in fineness of fibre.

Produce and Uses.—The produce of hemp fibre usually varies from 4 to 6 cwt. per acre; and the produce of seed is commonly from ten to twelve bushels, and sometimes very much more.

Hemp is used for making canvass and all kinds of cordage; and is well-adapted for these purposes by the great elasticity of its fibre. It is also used for the manufacture of coarse towels, coarse table-cloths, and other coarse fabrics suited to domestic economy; and the finer kinds of it are employed for making many sorts of cloths to serve as substitutes for linens. Hemp fabrics are incomparably stronger and more durable than flax ones; they are equally susceptible of bleaching; and they possess the singular recommendation of improving in colour by wearing, while flax fabrics become dusky and dull.

Growing hemp possesses the remarkable property of killing caterpillars and imago-insects which feed on cabbages and other vegetables; and therefore is often raised, on Continental Europe, in belts round gardens and fields, with the main view of protecting cultivated vegetables from injury.—The refuse of hemp dressings, technically called "hemp sheaves," are used as fuel.—The leaves of hemp, in India, are frequently added to tobacco and smoked along with it to increase its narcotic power; and are sometimes administered in cases of diarrhœa; and are mixed up with turmeric, onions, and warm gingilie oil, as an application for painful swellings.—The seeds in Russia and Poland are bruised or roasted, and mixed with salt, and eaten on bread.—An oil, yielded by the seeds, is used by painters,—is limpid, odourless, and suitable for burning in house-lamps,—and is used, in various parts of Continental Europe, and particularly in Russia, in culinary preparations, or as a sauce and condiment in food.—*Transactions of the Highland Society.—Quarterly Journal of Agriculture.—Mill's Husbandry.—Ainslie's Materia Medica of Hindostan.—Anderson's Commercial Dictionary.—Loudon's Works.—Lawson's Agriculturist's Manual.—Sir John Sinclair's General Report of Scotland.—Sproule's Treatise on Agriculture.—Knowledge Society's Farmer's Series.—Society of Gentlemen's Complete Farmer.—Low's Elements of Agriculture.*

HEMP-AGRIMONY. See EUPATORIUM.

HEMP-NETTLE,—botanically *Galeopsis*. A genus of hardy, weedy, annual plants, of the labiate order. The red hemp-nettle or ladanum, *Galeopsis ladanum*, infests the fields of the calcareous districts of Britain. Its root is twisted and has numerous fibres; its stem has opposite, leafy, reddish, pubescent, and crossing branches, and is about 9 or 10 inches high; its leaves are spreading, lanceolate, sometimes almost linear, and often very much varied; and its flowers grow in dense whorls, and have a pink colour variegated with red and white, and bloom from July till September.—The villous or downy hemp-nettle, *Galeopsis villosa* or *Galeopsis ochroleuca*, infests the sandy cultivated soils of many parts of Britain. Its stem is 12 or 15 inches high; its leaves are clothed with a soft velvety down; and its flowers are large, and have a beautiful sulphur colour, and bloom in July and August.—The common hemp-nettle or tetrahit, *Galeopsis tetrahit*, is a common weed of corn-fields. Its stem is bristly and about 20 inches high; its leaves are large, ovate, dark green, pubescent, and coarsely serrated, and yield a strong odour when bruised; and its flowers grow in dense whorls, are various in size, and sometimes wholly white, sometimes marked with dark-coloured lines, and bloom in July and August.—The changeable-coloured or large-flowered hemp-nettle, *Galeopsis versicolor* or *Galeopsis cannabina*, infests sandy cultivated soils in Britain. Its stem is 12 or 15 inches high; its leaves are broader and paler than those of the common species; and its flowers are much larger than those of that species, and have a yellow colour variegated on the palate with red or orange, and bloom in July and August.—Several species unknown in a wild state in Britain, occur in various parts of Continental Europe.

HEMP (VIRGINIAN). See ACNIDUS.

HEN. The female of the domestic cock, or type of the gallinaceous order of birds. See the articles COCK, POULTRY, and EGG.

HENBANE. A herbaceous, annual, British plant, of the natural order Solaneæ, growing to the height of about three feet, with sinuate leaves and yellow flowers veined with purple. It is a highly poisonous narcotic. See HYOSCYAMUS.

HENBIT. See ARCHANGEL and SPEEDWELL.

HENNA,—botanically *Lawsonia inermis*. A tall, tender, evergreen shrub, of the lythrum family. It grows wild in India, Egypt, and other warm countries; and was introduced, about the middle of last century, to the hothouses of Britain. It is sometimes called the broad-leaved Egyptian privet. Its stem is about 10 feet high; its branches are opposite, slender, and covered with a whitish-yellow bark; its leaves are opposite, small, oblong, pointed, and pale green; its flowers grow in loose bunches at the end of the branches, and have a dirty white colour; and its fruit are roundish, four-celled capsules, containing angular seeds. The Egyptian women use the leaves of this plant for staining the nails of their fingers yellow.

HEPATICA. A genus of small, hardy, perennial-rooted, spring-flowering, herbaceous, ornamental plants, of the ranunculus family.

The common three-lobed species, *H. triloba*,—called by Linnæus *Anemone hepatica*—was introduced to Britain from Continental Europe in the 16th century, and is one of the most common vernal beauties of all sorts of floral grounds, from the smallest plot of the humblest cottage to the largest borders of extensive gardens. It has itself a single purple-coloured flower; but it comprises a number of permanent and well-defined varieties,—particularly the blue-flowered, *H. t. cærulea*,—the double blue-flowered *H. t. cæruleo-plena*,—the red-flowered, *H. t. rubra*,—the double-red-flowered, *H. t. rubro-plena*,—the snow-white-flowered, *H. t. nivea*,—and the red-anthered white-flowered, *H. t. alba*. Its appearance is too well known to require description. All the varieties bloom from February till April; and the double-flowered varieties, besides being much more beautiful than the single-flowered ones, continue longer in bloom. The foliage of all has a neat and rather curious appearance, and serves as a kind of small winter ornament of the parterre, but suffers the very serious disadvantage of shrivelling and falling just before the plants start into bloom. All the varieties love a loamy soil and an eastern aspect, and dislike transplanting, and require to stand three years in the ground before exhibiting their full powers of flowering. Seeds may in any year be gathered from the single varieties; and may be sown in pots or boxes of light soil in August; and the pots or boxes ought to enjoy much shade till October, and be fully exposed to sunshine throughout the winter; and the seedlings ought to be transplanted into their permanent situations in the following August.

The American species, *H. americana*, was introduced, nearly 50 years ago, from North America. The normal plant has blue flowers; and two varieties, introduced about 12 years ago, have respectively white and red flowers.—The angulose and the acute-lobed species, *H. angulosa* and *H. acutiloba*, have blue flowers, and were introduced, about 30 years ago, from North America.—About 50 other species are known.

HEPATICÆ. A natural order of the foliaceous class of cellulares or cryptogamic plants. They are very nearly allied to the mosses; and were formerly regarded as a suborder of the mosses, under the name of *Musci hepaticæ*, while the true mosses were regarded as another suborder under the name of *Musci frondosi*. They have a general resemblance also to many of the lichens; but they are distinguished from the mosses by the dehiscence of their capsules, and from the lichens by the foliaceousness of their frondage, and by both their colour and their fruit. They are minute, creeping, and herbaceous; their frondage has the form of imbricated leaves; and their capsules split into longitudinal valves. They occur principally on the trunks of trees, in moist woods, on moist rocks, on moist heaths, in damp shady places, on the shelving banks of rivulets, and on moist spots by the sides of springs and ditches. They grow best in damp and cold weather; and, when faded or dried, they recover their vigour and healthy appearance when freely moistened with water. Many have no observable root; and others send out radical fibres from beneath the tiny expanse of their frondage. They are, for the most part, green; and they exhibit great beauty of structure when seen through the microscope. About 100 species occur in Great Britain; and between 12 and 15 of these are distributed among 5 genera; and all the others are comprised in the single genus *jungermannia*. The name hepaticæ is formed from a Greek word signifying "the liver;" and the plants are often popularly called liverworts, either from some slight resemblance of the form of their lobes to that of the liver, or because some of them were formerly employed as medicinal remedies for liver complaints. The ranunculaceous plants of the hepatica genus are sometimes called, for distinction's sake, noble liverworts.

HEPATITIS. Inflammation of the liver. See the articles INFLAMMATION and LIVER.

HEPS. See HIPS.

HEPTANDRIA. See BOTANY.

HERACANTHA. A genus of ornamental, annual plants, of the thistle division of the composite order. Four species, all hardy and about two feet high, two of them white-flowered and the other two yellow-flowered,—and all included by some botanists in the genus Carthamus,—have been introduced to Britain; and one of these, *H. lanata*—regarded by Linnæus as a Carthamus and by Decandole as a Cirsium—has been known in this country since before the close of the 16th century.

HERACLEUM. See COW-PARSNIP.

HERB, or HERBACEOUS PLANT. A non-ligneous plant. All herbs, no matter how the word is used, are soft, free from woody matter, and more or less green and cellular; and in the largest and most proper sense, herbs comprise all kinds of plants except trees, shrubs, and aphyllous cryptogams. But some persons mean by herbs only annuals and annual-stemmed perennials; and others, still more abitrarily, mean by them only such indigenous non-ligneous plants as are supposed to possess medicinal properties.

HERBAGE. Any green, succulent foliage, whether gramineous, leguminous, or otherwise, which forms a natural food of sheep and cattle, or can constitute any part of pasture.

HERB-AGRIMONY. See AGRIMONY.

HERBARIUM, or HORTUS SICCUS. An apellation given to a collection of specimens of plants, carefully dried and preserved. The value of such a collection is very evident, since a thousand minutiæ may be preserved in the well-dried specimens of plants, which the most accurate engraver would have omitted. Specimens ought to be collected when dry, and carried home in a tin box. Plants may be dried by pressing in a box of sand, or with a hot smoothing iron. Each of these has its advantages. If pressure be employed, a botanical press may be procured. The press is made of two smooth boards of hard wood, 18 inches long, 12 broad, and two thick. Screws must be fixed in each corner with nuts. If a press cannot easily be had, books may be employed. Next, some quires of unsized blotting paper must be provided. The specimens, when taken out of the tin box, must be carefully spread on a piece of pasteboard, covered with a single sheet of the paper, quite dry; then three or four sheets of the same paper must be placed above the plant, to imbibe the moisture as it is pressed out. It is then to be put into the press. As many plants as the press will hold may be piled up in this manner. At first, they ought to be pressed gently. After being pressed for about twenty-four hours, the plants ought to be examined, that any leaves or petals which have been folded may be spread out, and dry sheets of paper laid over them. They may now be replaced in the press, and a greater degree of pressure applied. The press ought to stand near a fire, or in the sunshine. After remaining two days in this situation, they should be again examined, and dry sheets of paper be laid over them. The pressure then ought to be considerably increased. After remaining three days longer in the press, the plants may be taken out, and such as are sufficiently dry may be put in a dry sheet of writing paper. Those plants which are succulent may require more pressure, and the blotting paper to be again renewed. Plants which dry very quickly ought to be pressed with considerable force when first put into the press; and, if delicate, the blotting paper should be changed every day. When the stem is woody, it may be thinned, with a knife, and, if the flower be thick or globular, as the thistle, one side of it may be cut away, as all that is necessary, in a specimen, is to preserve the character of the class, order, genus, and species. Plants may be dried in a box of sand in a more expeditious manner; and this method preserves the colour of some plants better. The specimens, after being pressed for 10 or 12 hours, must be laid within a sheet of blotting paper. The box must contain an inch deep of fine dry sand, on which the sheet is to be placed, and then covered with sand an inch thick; another sheet may then be deposited in the same manner, and so on, till the box be full. The box must be placed near a fire for two or three days. Then the sand must be carefully removed, and the plants examined. If not sufficiently dried, they may again be replaced in the same manner for a day or two. In drying plants with a hot smoothing iron, they must be placed within several sheets of blotting paper, and ironed till they become sufficiently dry. This method answers best for drying succulent and mucilaginous plants. When properly dried, the specimens should be placed in sheets of writing paper, and may be slightly fastened by making the top and bottom of the stalk pass through a slip of paper, cut for the purpose. The name of the genus and species should be written down, the place where it was found, nature of the soil, and the season of the year. These specimens may be collected into genera, orders and classes, and titled and preserved in a port-folio or cabinet. The method of preserving many of the cryptogamous plants is more difficult, on account of the greater quantity of moisture which they contain, and the greater delicacy of their texture.

The first object to be attended to in preserving marine plants, is to have them washed perfectly clean before spreading. It is a good practice to cleanse them before leaving the shore, either in the sea, or in a rocky pool. All foreign bodies, as fragments of decayed seaweeds, sand, gravel, or portions of the softened surface of the rock on which the specimens may have grown, together with the smaller testacea, and corallines, must be carefully removed. On getting home, it is further necessary to prepare each specimen by examining it in fresh or sea water in a white dish or plate, so that every foreign substance may be detected and removed. The next thing to be attended to is the quality of the paper on which the specimens are to be spread. A great error is generally committed in using it thin and of inferior quality. Indeed, much of the beauty of many species depends on the goodness of the paper, just as a print or drawing appears better or worse, as it is executed on paper of a good or an inferior kind. Some species contract so much in drying as to pucker the edges of the paper, if it be not sufficiently thick. That which has been found best is a thick music paper, closely resembling that used for drawing, and of which the sheet divides into four leaves about the size of royal octavo. Whatever pains may have been taken in cleaning the recent specimens, it is often found, when spreading them, that some foreign particles continue attached, and for the removal of these, a pair of dissecting forceps, and a camel-hair pencil of middle size, will be found very convenient. A silver probe, with a blunt and a sharp end, is the most convenient instrument for spreading out and separating branches from each other, but any thing with a rigid point, such as a large needle, or the handle of the camel-hair pencil, will answer. A large white dish serves for spreading the specimens in, and all that is further necessary is a quantity of drying papers, and some sheets of blotting paper, with three or four flat pieces of deal-board. Nothing answers better for drying than old newspapers, each divided into eight parts, but it is necessary to have a large supply of these.

The beautiful and common *Plocamium coccineum* is one of the most easily preserved species, and may be taken as an example of the mode of proceeding with most of the others. The steps to be pursued are as follow :—

1. The specimen is to be perfectly well cleaned.
2. A dinner dish to be filled about two-thirds with clean fresh water.
3. The paper on which the specimen is to be spread to be immersed in the water in the dish.
4. The specimen to be then placed on the paper, and spread out by means of the probe and camel-hair pencil.
5. The paper with the specimen on it to be then slowly withdrawn from the dish, sliding it over its edge.
6. The paper with the specimen adhering to it to be held up by one corner for a minute or two, to drain off the water.
7. To be then laid on a paper or cloth upon a table, and the superfluous water still remaining to be removed by repeated pressure of blotting

paper upon the specimen, beginning this operation at the edges, and gradually encroaching towards the centre, till the whole can be pressed upon without danger of any part adhering to the blotting paper, which probably would be the case were the latter applied at once to the whole specimen.

8. The specimen then to be laid on a couple of drying papers placed on a carpet or a table; two more papers to be laid over it, and then the piece of board, on which latter a few books are to be put, to give the necessary pressure.

9. These papers to be changed every half hour or oftener, till the specimen is sufficiently dry. A number of specimens, with drying papers interposed, may be pressed at once under the same board.

HERBA-ROTA,—botanically *Achillea Herba-Rota*. A hardy evergreen herb, of the milfoil genus, and chamomile division of the composite order. It was introduced from France in the former half of the 17th century; and it has undivided leaves, and a height of 5 or 6 inches, and carries white flowers in June and July. See the articles ACHILLEA, MILFOIL, and YARROW.

HERB-BENNET. See AVENS.

HERB-CHRISTOPHER. See BANEBERRY.

HERB-IMPIOUS. See GNAPHALIUM.

HERB-PARIS. See PARIS.

HERB-ROBERT. See GERANIUM.

HERCULES' CLUB,—botanically *Zanthoxylum Clava Herculis*. An ornamental evergreen shrub, of the toothache-tree genus, and rue family. It has a natural height of 10 or 12 feet, and carries greenish-white flowers in April and May. It is a native of the West Indies, and was introduced to Britain about 110 years ago, and is now only half-tender in our climate.

HERD. A number of grazing animals, feeding on one pasture, housed on one farm, or congregated under one owner. The name herd is often used, in Scotland and the north of England, in the sense of herdsman.

HERDSMAN. A person who attends a herd of cattle. He drives them to their pasture, restrains them within certain limits, prevents them from hurting one another, observes their condition as to disease or health, and exercises a general care over them during the periods of their absence from the farm-yard. A boy or girl is usually employed to tend a small flock; and an elderly man to tend a large one. But since the enclosing of lands became general, herdsmen of any kind are seldom required except on upland or moorish farms.

HERMANNIA. A genus of ornamental, evergreen, Cape-of-Good-Hope shrubs, of the byttneria order. Three or four species were introduced to Britain in the course of the former half of last century; and nearly forty species have been introduced at subsequent periods. Two have a height of 7 or 8 feet; but most have a height of between 2 and 3 feet. One is purple-flowered; one is striped-flowered; two are orange-flowered; and all the others have flowers of some shade of yellow. One blooms in winter; several bloom in early spring; two or three bloom throughout the greater part of the year; and most bloom in late spring and early summer. One of the earliest-introduced has many irregular branches, brown bark, cuneiform leaves of about an inch in length, and small, deep-yellow, spike-arranged flowers; and another has many spreading branches, rough, sessile, and comparatively small leaves, and such a profusion of bright yellow flowers at the ends of its shoots as to appear almost like one mass of bloom. All the species are propagated from cuttings.

HERMAPHRODITE. A term formerly applied exclusively to signify a human creature possessed of the organs of both sexes. The term is now applied to other animals, and to plants. It is now well known there is no such thing as an hermaphrodite in the human species. In many of the inferior tribes of animals, the male and female parts of generation are found to be united in the same animal. There are both natural and unnatural or monstrous hermaphrodites. The natural kind belongs to the inferior and more simple orders of animals; but, as animals become more complicated, and each part is more confined to a particular use, a separation of the sexual characteristics takes place, and they are found united only in some particular cases. In the horse, ass, sheep and cattle, such instances sometimes occur. In the case of cattle, when a cow brings forth two calves, one a bull, and the other a cow to appearance, the latter, in most instances, is unfit for propagation. See the article FREE-MARTIN. Among the invertebral animals, such as worms, snails, leeches, &c., hermaphrodites are frequent. In the memoirs of the French academy, we have an account of this very extraordinary kind of hermaphrodites, which not only have both sexes, but do the office of both at the same time. Such are earth-worms, round-tailed worms, found in the intestines of men and horses, land-snails, and those of fresh-waters, and all sorts of leeches. Among the animals of this sort, however, there are great numbers which are so far from being hermaphrodites, that they are of no sex at all. Of this kind are all the caterpillars, maggots and worms produced of the eggs of flies of all kinds. But the reason of this is plain: these are not animals in a perfect state, but disguises under which animals lurk. They have no business with the propagating of their species, but are to be transformed into animals of another kind, by the putting off their several coverings; and then only they are in their perfect state, and therefore then only show the differences of sex. When they have reached this state, they unite, and their eggs produce those creatures which show no sex till they arrive at that perfect state again.

HERMINIUM. A curious, bulbous-rooted, indigenous plant, of the orchis order. It constitutes a genus of itself, and takes for its specific name *monorchis* or one-bulbed; but it was regarded by the older botanists as an ophrys, under the name of *Ophrys monorchis*. It occurs on the banks of the chalk districts of England; and it has greenish flowers, and blooms in June and July. See the article OPHRYS.

HERMIONE. A genus of ornamental, bulbous-rooted plants, of the amaryllis family. The spreading-crown species, *H. aperticorona*, is a native of North Africa, and proves to be hardy in Britain. Its flower-stem is about a foot high, and its flowers have a yellow and orange colour, and bloom in April.

HERNANDIA. A small genus of tropical, evergreen, ornamental trees, of the laurel order. The sounding species, or Jack-in-a-box, *H. sonora*, grows wild in many parts of the West Indies, and was introduced to Britain toward the close of the 17th century. Its stem naturally attains a height of 50 or 60 feet; and its fruit, when ripe, is perforated, and contains a hard nut, and makes a loud whistling noise during a breeze of wind. Two other species, the egg-bearing and the Guiana, both about the same natural height as the preceding, have been added to the botanical collections of Britain.

HERNIA. See RUPTURE.

HERNIARIA. See RUPTUREWORT.

HERON. A tribe of birds very numerous, and almost universally spread over the globe. They are distinguished by having a long bill cleft beneath the eyes, a compressed body, long slender legs, and moderate wings: the tail is short, rounded, and composed of ten or twelve feathers. They are dull, inanimate birds, and are generally seen either perched on trees near the water, or wading in search of food. They feed exclusively on animals, particularly fish and reptiles. The common heron of Europe, *Ardea major*, is about three feet two inches in length, and five feet three inches in breadth from tip to tip; the body is exceedingly small, weighing scarcely more than three pounds and a half. It always has a lean and starved look, and, according to Buffon, presents the image of suffering anxiety and indigence. Though, in times of frost and scarcity, herons can exist for a long time with a very scanty supply of food, in favourable weather they gorge themselves with insatiable voracity. They are very expert fishers, and take their prey either by wading after it where the water is shallow, or by diving from the air, when the object of their pursuit appears near the surface of the water. They digest an enormous load of food in a short time, and again return to their destructive occupation, with new vigour and appetite. Willoughby asserts, that a single heron will destroy 15,000 carp in half-a-year. Notwithstanding their size and powerful beak, herons will fly from the smallest of the falcon tribe. The flesh of the young heron was formerly a dish in high repute. The most remarkable of the European herons are the egrets (*A. alba*, which is also found in America, and *A. gazetta*). These are distinguished by a large bunch of soft feathers rising from the shoulders, and hanging down over the back and sides. These feathers were formerly worn by knights in their helmets, and still form a decoration for ladies' head-dresses. Herons build socially on high trees, laying about four eggs. All the species fly gracefully, with the neck bent backwards, and the head resting against the back. The females resemble the males. The young differ from the adult, not obtaining their full plumage until after the third year. They moult annually, when the long slender feathers are also shed, and not renewed for some time.

HERON'S-BILL,—botanically *Erodium*. A genus of plants, of the geranium order. Three species grow wild in Britain; nearly 40 have been introduced from other countries,—principally those bordering on the Mediterranean; and nearly 20 more are known. One of the introduced species is a dwarfish, evergreen, Cape-of-Good-Hope, under-shrub; five or six are frame, evergreen herbs; two or three are hardy biennials; and about one half of the remainder are hardy annuals, and the other half hardy radical perennials. The flowers of most have a purple colour; and those of the others are blue, red, pink, carmine, or white. Some of the species, as two of the indigenous ones, and at least five or six of the others, are sheer weeds; many are more or less beautiful; and a few, as *E. petreum*, *maritimum*, *crassifolium*, *incarnatum*, *Reichardi*, *alpinum*, *glandulosum*, and *hymenodes*, are well worthy of a place in the flower-garden.

The hemlock-leaved heron's-bill, *Erodium cicutarium*, is an annual weed of road-sides and waste grounds in both England and Scotland. Its stem is 9 or 10 inches high; its leaves are pinnate; and its flowers are purple, and bloom from April till September.—The sea heron's-bill, *Erodium maritimum*, grows wild on the sandy shores of some parts of England. Its root is perennial; its stem is only two or three inches high; and its flowers are flesh-coloured, and bloom from May till September.—The musk heron's-bill, *Erodium moschatum*, is a handsome annual indigen of the upland pastures of England. Its stem is about a foot high; and its flowers are purple, and bloom from May till July. Both the popular name of the genus, and the botanical one, allude to the fancied resemblance of the shape of the fruit to that of the head and bill of a heron.

HERRERIA. A small genus of tropical, evergreen, twining plants, of the asphodel order. Two species, *H. parviflora* and *H. stellata*, both 8 or 9 feet high, and carrying greenish-yellow flowers in summer, and the latter a cultivated ant, were introduced to British hothouses, out 22 years ago, from South America.

HERRING, — scientifically *Clupea Harengus.* well-known, soft-finned fish, constituting the pe of a family of abdominal malacopterygians. he fishes of this family have no adipose fin; eir upper jaw is formed by the maxillaries on e sides, and by intermaxillaries without pedils in the middle; and their body is, in every stance, covered with numerous scales. The roup most nearly allied to the common herng,—often called the true herrings, and comrising the sprat, the white-bait, the pilchard, e sardine, the shad, and the chatoossi—"have vo well-marked characters in the narrow and ort intermaxillaries, that constitute but a nall portion of the upper jaw, the sides of hich are completed by the maxillaries, so that ese sides are alone protractile,—and in the ferior edge of the body, which is compressed, nd where the scales are dentated as in the edge f a saw; the maxillaries are divided into three ieces; the branchiæ are so much cleft, that all e fishes of the genus are said to die instantly hen taken from the water; the sides of the ranchial rays next to the mouth are pectinirm; the stomach is an elongated sac; the atatory bladder long and pointed, and the eca numerous; of all the fishes, these have the nest and most numerous bones." [Cuvier's nimal Kingdom.]

Description of the Herring.—The common herng, though one of the most celebrated of fishes, nd familiarly recognizable by the great majority f our population, may well bear a little extended escription. The head is one-fifth of the total ngth of the fish. The under jaw is longer than e upper one. The teeth of both jaws are isible. A scaly carinated line runs along the elly, from the head to the tail. The fins are even in number,—one dorsal, two ventral, one nal, two pectoral, and one caudal or the tail. he dorsal has 17 or 18 rays; the ventrals rise om under the middle of the dorsal, and have ach 9 rays; the anal has from 14 to 17 rays; he pectorals have each from 15 to 18 rays; and he tail has from 18 to 20 rays. The eyes are tuated on the sides of the head, at points near he middle of its length; and their iris is of a lvery-white colour, and the pupil black. The ales lie over one another in regular lines, with he convex edges pointing from the head toward he tail, so as to form series of small segments r concave edges pointing to the head; and so ng as the fish continues perfectly fresh, the ack is of a dark-bluish and green colour, the des and belly are silvery, the scales are lusously and elegantly golden or orange, and the udal extremity, when held before the light, xhibits a beautiful dark-green. The spine consts of 56 vertebræ; the cavity of the belly terinates at the anal fin; the sides, so far as they ank the cavity, have each 35 or 36 ribs; the sides, between the cavity and the tail, are fortified with several minute bones, terminating in soft elastic muscles; and the head comprises no fewer than 52 bones. Four gills or bronchiæ are situated on each side; and each gill is supported by a cartilaginous arch. The heart lies in a cavity near the gills, and at the upper part of the stomach; and is three-sided, and consists of a single auricle and a single ventricle,—the former receiving the blood from the body, and sending it to the ventricle, and the latter sending it through a minutely ramified artery to the gills. The gullet is remarkably short. The stomach is thin, membranous, and capable of great distension. The gut is everywhere of one size. The gall-bladder is small and dark-green, and contains a sweetish, light claret-coloured, and somewhat pungent liquid. The air-bag or swimming-bladder is connected with the posterior part of the stomach by a duct; and is nearly as long as the stomach, narrow and pointed at both ends, and of a silvery-white colour. The nose possesses, in its mere form and consistency, a similar capacity of feeling to that which is lodged in the cirri of other fishes; and it is provided with two nostrils, and is supposed to possess a comparatively keen sense of smell, as a chief means of enabling the animal to select its food. No external organs of hearing exist; yet herrings are generally believed by fishermen to be somewhat easily scared by loud and unusual sounds.

Economy and Habits of the Herring.—The food of herrings consists of animalcules, small cancri, the oniscus marinus, small medusæ, various other minute sea-animals, young sand-eels, sometimes flies, and occasionally their own spawn or young. They deposit their spawn on hard clayey or rocky ground or gravel in bays, sea-lochs, and the mouths of rivers; and, immediately after spawning, they proceed to sea. The female, in spawning, selects a suitable locality, remains some time quiescent at the bottom, and deposits at once the whole of the roe; and the male, now having the milt thoroughly matured, and converted from a solid mass into a rich creamy-looking liquid, emits it in such a manner as to impregnate the roe's multitudinous ovules. Each female has two roes, and each male two milts; and the roes of a female, whose whole body weighed 5 oz. 10 dr., was found by Dr. Harmer to have a weight of 480 grains, and to contain 36,960 ovules. The ejected and impregnated roe becomes a firm, coherent mass, somewhat larger than the unejected roe; and it attaches itself so powerfully to the rock, gravel, hard clay, seaweed, or other material of the spawning locality, that, till either dead or dried, it cannot, without great difficulty, be removed or separated. Many detached ovules, from a spawning ground, are found indeed upon the nets of fishermen: but all these are dead or unfecundated, and have been taken off by the attrition of the twine of the nets. The ovules of the fecundated masses, not only cohere together, and unitedly adhere to the ground, but are, in a considerable degree, protected both from storms and from the depredations of fishes; and they probably lie lodged in the precise situations best provided, not merely with the general conditions of incubation, but with suitable food for the newly hatched herringules. The eyes are first observable in each ovule; the head next appears; the whole fishling is matured in from 14 to 21 days; and it becomes about 3 inches long in 6 or 7 weeks, and probably attains its full size in about 18 months. The young herrings, when 3 inches long and upward, may be observed, in winter and spring, moving in large shoals up and down the bays and estuaries which are usually frequented by the shoals of the full-grown fishes.

The herring skulls itself through the water by the action of its tail; and steadies its forward motion, as well as rises or descends, by means of its other fins. When a shoal of herrings swims near the surface of the water in calm weather, the sound of their motion is audible at a small distance like the rippling of water or the pattering of rain; and when they move rapidly at night, they throw off a phosphorescence which appears like a beautiful bright line or belt. But all the full-grown and healthy herrings generally swim at a considerable depth, and only the young, the full, and the sick swim near the surface; so that the indication waited for by the fishermen of the north-west of Scotland, and of other districts, of flocks of gulls, large fishes, and other appearances of the pursuit of shoals, is exceedingly deceptive, and points only to small and worthless detachments, at the expense of neglecting the main army of the herrings. Shoals are considerably controlled in their destination by comparative excess of light and heat, and spawn in much deeper water and at a much greater distance from the shore in a summer of extraordinary sunshine and warmth than in an ordinary or especially a cloudy and coldish summer; and hence the deep-sea herring fishermen of Holland are sometimes eminently successful, when the in-shore herring fishermen of Britain encounter more or less of failure. The inhabitants of some parts of the North American coasts have carried away herring-spawn, and deposited it in places never known to have been frequented by herrings; and they have found these places to be thenceforth good herring-grounds,—frequented probably by both the fishes which sprang from the spawn, and by others whom these brought in their company.

Migrations of the Herring.—Herrings have been represented by very many writers as having their home in the arctic seas,—as forming the common food of the whales and other huge sea-animals of the coasts of Greenland, Spitzbergen, and Labrador,—as making a consentaneous annual migration to the south, partly in order to spawn, and partly in order to escape during the spawning season from their devourers,—and as dividing into two great bodies at the northern extremity of Scotland, the one body to proceed southward along the east coast of Scotland and England, and the other to proceed through the Deucaledonian sea and around the coasts of Ireland. Even some writers who hesitate to regard them as inhabitants of the seas around Greenland, suppose them to have a general rendezvous in latitudes considerably north of Shetland, and fully subscribe to the theory of their consentaneous annual migration. But strong reasons can be assigned to show, that herrings neither form one community nor make any general migration, —that they have no collective connexion whatever with the seas north of Shetland,—that they are natives of the localities, or of the vicinities of the localities, which they severally frequent, —and that they migrate only between the in-shore parts of a coast for spawning, and the deep-sea parts of the same coast for maturing and feeding.

The whales and other huge sea-animals which inhabit the arctic seas, have never been found, from post mortem examination of the contents of their stomachs, to have swallowed any herrings. The common whale, or *Balæna mysticetus*, feeds on actiniæ, sepiæ, medusæ, cancri, and helices; the narwhal is not certainly known to eat anything but sepiæ; and the walrus feeds on shrimps, crawfish, and young seals. The only whales known to feed more or less on herrings are those which frequent the seas of the herring-fisheries,—such as the *Balænoptera rostrata*, which inhabits principally the Norwegian seas, and the *Balænoptera musculus*, which frequents the shores of Norway, Scotland, and Ireland.

Other fishes which possess similar habits of spawning to those of the herring, and which make regular appearances and disappearances on our shores, have never been supposed to congregate into one great community, or to migrate further from the spawning-grounds than to the adjacent deep seas. The salmon ascends almost all British rivers, at particular seasons, to spawn; the sprat appears in shoals, in various parts of the British coasts from November till March; the shad occurs in shoals, in some of our rivers, from May till July, and appears in the Mediterranean, and ascends the Nile as high as Cairo, in December and January; the pilchard appears in shoals, on the coast of Cornwall, from June till the end of the year; and the tunny comes in-shore, on the coasts of the Mediterranean, in summer. Yet though all these fishes, as truly and regularly as the herring, gregariously visit certain coasts and rivers at particular seasons, none of them are imagined to be natives of a remote frigid region, or to be mere annual and far-distant immigrants in the places of their periodical appearance.

Herrings do not seem to possess the power of locomotion at a higher rate than about half a mile a-day; or, at all events, are similar in size and structure to fishes which have been ascertained to possess no higher a power; so that they are physically unable to effect any such lengths of journey as annual migration from the arctic to the British seas.—Herrings are not certainly known to move southward, except in approaching a coast; and no herrings which move southward are known to return northward.—If herrings move southward in order to escape from whales, what reason, as Bloch pertinently asks, can be assigned for their returning to the north?—Some herrings are supposed by the celebrated naturalists Bloch and Yarrell, to occur either on or very near the spawning-grounds at every time of the year; some are believed or even known by old fishermen to occur at all seasons in Loch Fyne and other distinguished fishing-grounds; and either young or old ones are well known to exist in the Frith of Forth in every month of the year.—Herrings are not authentically recorded, in even one instance, to have been seen coming southward in shoals within any high northern latitude.

The respective seasons of the herrings' appearance on the several fishing-grounds of Britain, indicate far more independent approaches from the adjacent seas than any one immigration from a common home. Herrings, for example, are caught in Loch Fyne in June before any are caught near Cape Wrath; and off Berwickshire and Aberdeenshire by the Dutch, before any are caught off Caithness; and even off Yarmouth in May and April, before any are caught in places farther north; and generally on the east coast of Scotland before any are caught on the west coast. "There can be no doubt," remarks Yarrell, "that the herring inhabits the deep water all round our coast, and only approaches the shore for the purpose of depositing its spawn within the immediate influence of the two principal agents in vivification,—increased temperature and oxygen."

But the most convincing proof of all, and at the same time a fact of great practical interest, is, that the herrings caught on different fishing-grounds have marked and almost specific differences of size, shape, and quality. Persons well experienced in the herring trade, can, upon the most cursory examination of any specimen, name the precise locality where it was found. "The size of the herrings caught off the projecting coast of Stadtland in Norway, for example, is almost twice that of those caught off Shetland, which kind again is nearly twice as large as those caught off Thurso; and the first caught Thurso herrings are considerably smaller than the Isle of Man, Minch, and Loch Fyne herrings, much smaller than the Caithness and Banff herrings, and not above half the size of the herrings caught off Aberdeenshire, Fifeshire, and Berwickshire. Again, the Yarmouth caught herrings are much smaller than those of Aberdeenshire and Berwickshire, and those caught on the coast of Holland considerably larger than those caught at Yarmouth. A size of herrings similar to the Yarmouth fish till lately visited Lümford in Denmark in great quantity. Now, on the Mecklenburg coast higher up the Baltic, the size of the herrings is one-third larger than those of Lümford; and proceeding up the Baltic coast above Mecklenburg, namely, on the Pomeranian and part of the Prussian coasts, the herrings are fully one-third smaller; and again, still farther up, they are larger, and about the size of the Moray Frith herrings. Thus, the theorists who argue that the herrings come from the north must furnish two rare kinds of herrings, namely, one kind, which, in its progress southward, grows smaller on its journey, and another which grows larger. As to quality, nothing so much proclaims the error of the tale of their southern journey, as the general state of the herring. For instance, as already mentioned, those caught off Shetland are not nearly so fat as those caught about the same time on the coast from Thurso to Loch Broom. In the first of the season, those caught in Loch Fyne are not so extremely fat as the Thurso herrings. The herrings of Loch Fyne are much superior in quality to those of the east coast off Berwickshire and Aberdeenshire. Again, there is a marked difference in appearance and quality, between those got near Caithness and Moray shires, and those caught off Aberdeenshire and Berwickshire. The quality of the Danish and Baltic herrings is much inferior to the Shetland and West Highland herrings, and those caught on the coast of Holland are so very inferior, as not to be pickled at all by the Dutch. The Yarmouth herrings are inferior in some respects to those of the north of Scotland, and the herrings got on the French coasts are also of inferior quality."

The Use of Herrings for Manure.—Herrings have, in some rare instances, been caught in such enormous quantities, as to have been spread on the fields, in their whole state, for manure. But such an use of them is a wasteful and wicked abuse of the bounties of Divine Providence, and even a very short-sighted piece of mere ordinary policy; for it can occur only when a community of herrings spawn unusually near the shore, and is certain to be followed for several years by a comparative scarcity in the fishery. Both the refuse of fresh herrings and the brine of salt herrings, however, are directly available for manure, and possess a highly fertilizing power. See the articles FISH and BRINE. "The herring fishery at Peterhead," says the author of a Prize Essay in the Highland Society's Transactions, "has added much to the Agricultural prosperity of the adjoining districts. It has been established that the refuse of herrings is equal to any other manure hitherto made use of; and it may be carried to a considerable distance from the coast at little expense. The refuse of the herrings caught by one boat will, along with the dog-fish, on an average, be sufficient manure for two acres of land." A kind of cake is made in Sweden by the herring-oil manufacturers, and is regarded by the farmers of that country as a very valuable and efficient manure; and the herring refuse of many of the British fisheries, particularly of those adjacent to well-farmed districts, is now very generally appreciated as a fertilizer.

HESPERANTHA. See Evening Flower.

HESPERIS. See Rocket.

HETERANTHERA. A genus of beautiful, floating, aquatic plants, of the pontaderia family. Two blue-flowered species, and a white-flowered one, have been introduced to Britain from America; and four or five other species are known. One of the introduced blue-flowered species, *H. limosa*, is hardy, and a lover of bog-mud; and the other two have kidney-shaped leaves, and are tender, and live solely in water, and are propagated from suckers.

HETEROPOGON. A small genus of curious grasses of the villiflorous tribe. Two species, Allioni's and the twisted—both perennial-rooted, autumn-flowering, and about two feet high—have been introduced to the botanical collections of Britain from respectively Switzerland and India; and the latter is regarded by some botanists as an andropogon.

HETEROPTERIS. A genus of ornamental tropical plants, of the barbadoes cherry order. Four evergreen shrubby species, and 4 or 5 evergreen climbing species, all about 10 or 12 feet high, and carrying either purple, blue, or yellow flowers, have been introduced to Britain from tropical America; and some more species are known.

HETEROTROPA. A recently discovered and very remarkable plant, of the asarabacca family. It constitutes a genus of itself, and takes for its specific name *asaroides;* and it botanically differs from the common asarabacca principally in the arrangement of its stamens, the structure of its anthers, and the nearly superior position of its ovary. It was brought from Japan in 1836. Its stem is very short; its leaves are two in number, and stand on coloured petioles of 3½ inches in length; its flower is sessile, cartilaginous, and as large as a walnut, and emits an odour somewhat like that of a ripe apple; and the tube of the flower is spheroid and of a dull purple colour blotched with grey,—and the limb three-partite, reflected, and of a darker purple than the tube.

HEUCHERA. A genus of hardy, perennial-rooted, herbaceous, ornamental, North American plants, of the saxifrage order. Seven or eight species, varying in height from 8 inches to a yard, and carrying either purple, pink, or white flowers, in the early part of summer, have been introduced to Britain. The largest known species, *H. Americana*, is a native of Virginia; and has been called the American sanicle, and the mitella of America. Its leaves are numerous, ovate-cordate, crenated, smooth, and lucid green; its flower-stem rises from among the leaves, and is naked, and attains a height of about a foot; and its flowers are small, hairy, numerous, and of a dull purple colour, and grow in a loose panicle.

HEXANDRIA. See Botany.

HIBBERTIA. A genus of very beautiful, evergreen, ligneous, yellow-flowered Australian plants, of the dillenia order. Three twining species, of from 6 to 9 feet in height, and 7 or 8 shrubby species of 2 or 3 feet in height, have been introduced to Britain; and 9 or 10 more are known. These plants are somewhat closely akin to the true dillenias; and consequently rank high in the scale of ornament. See the article Dillenia.

HIBERNIA. See Geometers.

HIBISCUS. A large and diversified genus of ornamental plants, of the mallow order. It comprises annuals, biennials, radical perennials, herbaceous evergreens, deciduous shrubs, evergreen shrubs, and small evergreen trees; and it is naturally distributed through most parts of the world, and furnishes to our gardens subjects of every department of culture, from the open ground to the stove. Almost all its species are showy; and very many are brilliant and eminently beautiful. About 90 species have been introduced to British gardens; and about 40 more are known. We can afford to make but brief particular mention of only a few of the species.

The Syrian species, a beautiful deciduous shrub, of several varieties, is noticed in the article Althæa Frutex; and two curious and common hardy annual species are noticed in the article Bladder-Ketmia.—The Chinese rose or China Ketmia, *H. Rosa-sinensis*, was introduced about 115 years ago from India. It is a lofty evergreen shrub. Its stem is soft and spongy when young, and ligneous and pithy when old, and usually has a height of from 10 to 14 feet; its branches are numerous, spreading, and leafy, and those toward the top are hairy; its leaves are heart-shaped, and cut into five acute angles on their borders, and lucid green above, but pale below; its flowers are axillary, outspread, and dark-red, and bloom in July and August; and its capsules are short, thick, blunt, five-celled, and very hairy, and contain many small kidney-shaped seeds. The petals are used in China and Batavia to blacken eyelashes and shoe-leather; the roots, triturated with oil, are used in some parts of India for menorrhagia; and the whole plant—probably from the Chinese use of it—is commonly known among the Indo-British as the shoe-flower. Five very beautiful varieties have long been cultivated in hothouses,—the double red, the double yellow, the double pale yellow, the double flesh-coloured, and the double variegated.

The attenuated-leaved hibiscus, *H. attenuatus*, is a perennial-rooted herb. Its stem is from 5 to 7 feet high; its leaves are smooth, elliptic, and prolonged into an attenuated and acuminated point; and its flowers are axillary, peduncled, 3 inches long, 5 inches across, and of a lovely rosy hue. It requires frame-heat.—The many-parted-leaved hibiscus was introduced from Australia in 1837. It is a regularly formed conical bush of 3 or 4 feet in height; and is singularly imposing in almost all the properties of an ornamental plant. "Its outline and leaves are eminently pleasing; while the blooms, when properly unfolded, are superlatively lovely. The light delicate azure which constitutes the standard colour of the latter, is shown to excellent advantage by the finely-rounded and gradually-opening cup of the corolla, and merges beautifully into a lively crimson towards the centre, which is again prettily contrasted with the yellow and brown of the staminal processes."—The sabdariffa hibiscus, *H. sabdariffa*, was introduced from India toward the close of the 16th century. Its root is biennial; its stem is about two feet high; and its flowers are yellow, and bloom from June till September. This plant is cultivated on the Coromandel Coast, and grows very luxuriantly in the West Indies; and its calyx is used in the former country for making tarts and jelly, and in the latter for making a kind of cyder or wine.—The hemp-leaved hibiscus, *H. cannabinus*, was introduced from India about the middle of last century. Its root is biennial; its stem is 5 or 6 feet high; and its flowers are outspread, and have a combination of white and purple colours, and bloom in June and July. The tough stringy fibres of this plant are used in India for making cordage.—The splendid hibiscus, *H. splendens*, was introduced from Australia in 1828. It is an evergreen shrub of great beauty, and about 10 or 12 feet high, and carries rose-coloured flowers in the early part of summer.—Lindley's hibiscus, *H. Lindlei*, was introduced about 20 years ago from India. It is an evergreen shrub of 3 or 4 feet in height, and carries purple-coloured flowers, and has the rare property of blooming in the middle of winter.—Some further notice of this magnificent and singularly opulent genus will occur under the word Ketmia.

HICKERY. See Carya.

HIDE. The skin of a cow, an ox, a horse, or any other large quadruped. The hides of cattle of good breeds are thin, moveable, mellow, and well-clothed with fine soft hair, yet not so loose as to offer no resistance to the touch, nor so thin as to indicate want of hardiness of constitution. See the articles Cattle and Breeding. A raw or green hide, in commercial language, is a hide in a fresh state, or when taken off the carcase; a salted hide is one which has been dressed with alum, saltpetre, and common salt, in order to preserve it from putrefaction; a tanned hide is a salted and preserved hide which has undergone the process of tanning; and a curried hide is one which has been finally dressed by the currier, and possesses all the characters of leather.

HIDE-BOUND. A diseased condition of the skin of horses and cattle. The hide fails to possess the oily secretion which is requisite to keep it soft and mellow; it becomes hard, dry, and unyielding; it appears as if glued firm to the muscles and the bones; and it suffers such a refractoriness of the minute scales of its cuticle, that the hair is irregularly disposed, and forms a rough, ragged, staring coat. Yet hide-bound is not properly a disease itself, but rather the symptom of any one of many diseases. It results from grease, farcy, founder, chronic cough, worms, prolonged glanders, poor diet, all sorts of diseases of the digestive organs, and various disorders of obscure seat or ill-defined character. The grand remedy for it, of course, is to attack and overthrow the disease which causes it. But when that disease cannot be discovered, or even sometimes as an accompaniment to the main treatment when the disease is quite apparent, a few mashes, a little physic, an antimonial alterative, and regularly repeated frictions are often successful in removing hide-bound. An instance of empirical treatment of hide-bound in a horse is mentioned by White, which strikingly illustrates the combined ignorance and barbarity of farrier-quacks:—"The head and legs of the horse having been secured, two men, one on each side, pulled the hide from the ribs in about fifty places with pincers!"

HIDE OF LAND. An ancient measure of arable ground. It comprised as much land as could be ploughed in one year with one plough and team; and, therefore, was sometimes called a ploughland. It is variously estimated at 60, 80, and 100 acres. The distribution of England into ploughlands or hides of land was very ancient, and is mentioned in the laws of Ina; and a tax called hideage was imposed by Henry I. in order to raise a dowry for his daughter, and consisted in the exaction of three shillings for every hide of land.

HIERACIUM. See Hawkweed.

HIEROCHLOE. A genus of grasses, of the oat tribe. The northern hierochloe, or northern holy-grass, *H. borealis*—called by Schrader *Holcus borealis*, and by Linnæus *Holcus odoratus*—is an indigen of the mountains of Scotland, and of corresponding situations in Continental Europe. Its root is perennial and powerfully creeping; its culm is usually from 12 to 18 inches high; its leaves are flat, naked, and somewhat broad; its panicle is erect and somewhat unilateral, and has slender, wavy branches; and its perfect florets are awnless, and the barren ones slightly awned, and bloom in May and June. This grass matures very few seeds; but it is very readily and rapidly propagated by its creeping roots. In the Woburn experiments, it yielded per acre, when in flower, 9,528 lbs. of green produce, 2,441 lbs. of dry produce, and 632 lbs. of nutritive matter,—and when ripe, 27,225 lbs. of green produce, 9,528 lbs. of dry produce, and 2,233 lbs. of nutritive matter. This grass is used in some parts of Continental Europe for strewing the floors of places of worship at certain festivals; and it thence acquired the name of holy-grass, and has, in modern botany, entailed that name, in the Grecianized form of hierochloe, upon the whole genus.—Two species, the southern and the fragrant, both perennial-rooted and about 12 or 15 inches high, have been introduced from respectively Southern Europe and North America; and several other species are known.

HIGH-BLOWER. A horse whose breathing, at a time of exertion, is accompanied with excessive dilatation of the nostrils, and with great puffing and blowing. Every such horse is more or less unsound. See the articles HORSE and BROKEN WIND.

HIGHLAND AND AGRICULTURAL SOCIETY OF SCOTLAND. See AGRICULTURAL SOCIETIES.

HIGHLAND PONY. See HORSE.

HIGHWAY. A public road, or road which any person has a right to use, whether the road be fit only for foot passengers or fit also for wheeled carriages. Any road which has been used by the public, or open to all persons, during 25 years, is permanently a highway; and any road which has been used by the public during four or five years, may continue without trespass to be so used till it is formally enclosed. Public roads acquired the name of highways from the raised causeways which constituted the "viæ" of the Romans. See the article ROAD.

HILL. Elevated ground, of medium character between mound and mountain, or between hillock and highland. But the name is altogether comparative; and equally applies to an elevation of 100 feet in a low and prevailingly level district, and to an elevation of 1,000 feet in a high and prevailingly mountainous district. Hills, also, have great variety of both shape and character, from the spreading down to the cliffy and beetling height, or from the isolated protrusion on a plain to the frontier range of a region of uplands, or from the rich arable slope to the barren moor or the naked crag.

The peculiarities of climate, weather, and vegetation on hills, as compared to plains and valleys, are noticed in the article ALTITUDE; and some economical considerations, in connexion with hills, are stated in the articles BARREN SOILS, DRAINING, FARM, GRASS-LANDS, PASTURE, CATTLE, SHEEP, and SHELTER. "Hills," somewhat quaintly says old Miller, "serve as screens to keep off the cold and nipping blasts of the northern and eastern winds; they serve to stop the evagation of vapours toward the poles, and condense them, like alembic heads, into clouds, and so by a kind of external distillation, give origin to springs and rivers; and by amassing, cooling, and constipating them, turn them into rain, and by that means render the fervid regions of the torrid zone habitable; and they serve for the production of a great number of vegetables and minerals, which are not found in other places." "If hills are rather numerous but only moderately high," remarks Legh, "they produce frequent rains throughout the neighbourhood, being high enough to attract and stop, but not high enough to retain and absorb, the clouds. Hence Kendal in Westmoreland, and Moffat in Dumfriesshire, are found to be exceedingly rainy. If the hills are very numerous, they produce rather more uncertainty than rain; for, as the wind varies, every hill has equal chance of attracting the clouds. Hence the uncertain weather in Wales and the Highlands of Scotland. The barometer is also found to vacillate in these countries as much as the weather. If the hills are still higher, they retain the clouds often in the form of snow-clouds, which may remain till warm clouds come to dissolve them, and then they pour down the mountains in the form of brooks and rivulets. If very high, they retain clouds to such an extent as actually to prevent rain altogether, as in the neighbourhood of the west of the Andes, which is free from rain. The effect there is very much increased by the wind, which clears the windward country from rain, while the water flows down its streams on the opposite sides of the mountains, producing the most gigantic rivers in the world, as the Amazon, which has 200 tributary streams as large as the Nile or the Danube."

HILLIA. A genus of tropical, ornamental, evergreen undershrubs, of the madder family. Two species, the long-flowered and the tetrandrous, both white-flowered and less than two feet in height, and the former blooming in February and March, have been introduced to the hothouses of Britain from the West Indies.

HILLOCK. A little hill or large mound. But the word has a wide range of application, from a tiny tumulus only a few inches high to a great and spreading elevation of 100 or 200 feet in height, such as in low and level countries would be called a hill or even a mountain.

HIND. See FARM-SERVANTS.

HINDSIA. A recently discovered genus of ornamental plants. The porcelain blue-flowered species, *H. violacea*, was introduced to Britain in 1844 from South Brazil. Its stem is branched and shrubby, yet scarcely ligneous; its leaves are large and oval, and stand on long stalks; and its flowers grow in clusters at the ends of the branches, and have a porcelain blue colour,—and each comprises a long narrow tube, a greatly dilated extremity, and five spreading petals, in the form of a star-shaped blossom.

HINK. A peculiar kind of sickle, used in the Isle of Thanet for reaping canary-grass.

HINNY. The hybrid offspring of a she-ass and a stallion. Its head is long and thin; its mane is short; and its ears are like those of a horse. It is much less common than the mule,—which is the hybrid offspring of a mare and a he-ass. See the article Mule.

HIP. The exterior part of the haunch of an animal; also, the fruit of a rose-plant.

HIPPARCHUS. See Geometers.

HIPPEASTRUM. A recently discovered genus of tropical, tuberous-rooted, ornamental plants, of the amaryllis order. Two species, *H. ambiguum* and *H. breviflorum*, were introduced to Britain, about 8 or 9 years ago, from South America; and another, *H. solandriflorum*, was introduced, a little later. All are very magnificent. The name hippeastrum signifies "a knight's star," and is intended to be descriptive.

HIPPION. A genus of tropical, ornamental, biennial plants, of the gentian family. Three summer-flowering species, varying in height from 12 to 30 inches, carrying respectively white, yellow, and fulvid flowers, and all assigned by some botanists to the genus exacum, have been introduced to Britain. See the article Exacum.

HIPPOCASTANEÆ. A small but imposing tribe of dendritic plants, having the common horse-chestnut for its type, and comprising the genera æsculus and pavia. See the article Æsculus.

HIPPOCRATEA. A genus of tropical, ornamental plants, constituting the type of the natural order Hippocrateaceæ. Nearly 20 species of this order have been introduced to Britain; and these belong to 5 genera, and are all climbing or dendritic shrubs of tropical climates, with simple opposite leaves, and small inconspicuous flowers. The genus hippocratea comprises 5 or 6 of the introduced species,—all greenish-white flowered, one an evergreen tree of 20 or 25 feet in height, and the others tall climbing evergreen shrubs; and it also comprises nearly 20 known unintroduced species.

HIPPOCREPIS. See Horse-Shoe Vetch.

HIPPOMANE. See Manchineel.

HIPPOMARATHRUM. Two hardy, perennial-rooted herbs, of the umbelliferous order,—popularly called horse-fennel and horse-poppy. Horse-fennel, *Hippomarathrum siculum*, constitutes a genus of itself, and is a curious, yellow-flowered, autumnal-blooming plant of about a yard in height, and was introduced about two centuries ago from Sicily; and the horse-poppy, *Seseli hippomarathrum*, belongs to the meadow-saxifrage genus, and is a purple-flowered and July-blooming plant of about 2 feet in height, and was introduced nearly two centuries ago from Austria.

HIPPOPATHOLOGY. The department of veterinary medical science which discusses the anatomy, diseases, and sanatory treatment of the horse. An old writer in this department, not yet quite forgotten, but sadly antiquated, is Bartlet. Another old writer, who survives in hippopathology very much as Miller does in gardening, and who wrote far in advance of the spirit of his age, is Gibson. Four of the most recent writers of most value are Youatt on the Horse, Percivall on Hippopathology, Delabere Blaine on the Veterinary Art, and Winter on the Horse in Health and Disease. Some of the best writers of monographs, or on limited and particular topics in hippopathology, are Dick, Coleman, Sewell, and various contributors to the Veterinarian. Writers of intermediate times between the old and the recent, or of intermediate character between the worst and the best, are very numerous; and some of the most prominent of them are Clater, White, Rydge, Stewart, Lawson, and Ephraim Blaine. Yet, in spite of the enormous bulk and the vast variety of our domestic hippopathological literature, and in spite too of the stupendous additions to it which are made by French and German works of easy access, the science continues to be incredibly little known by the great body of the horse-owning community, and is still in a scandalous empirical condition among a considerable proportion of country practitioners. Even if no books at all existed on the subject, a little common sense, expatiating on the analogies between the health of the horse and the health of man, ought to rescue grooms and farmers from the absurdities and cruelties which many of them practise in the stable. See the articles Abortion, Age of Animals, Amble, Anchylosis, Back, Backing, Back-Sinews, Bar-Shoe, Bit, Bleeding, Blindness, Blister, Bog-Spavin, Bone-Spavin, Bots, Breaking, Bridle, Broken-Knees, Broken-Wind, Bronchitis, Canker, Capulet, Castration, Cataract, Catarrh, Caustic, Colic, Cough, Crib-Biting, Curb, Dandriff, Diabetes, Diarrhœa, Docking, Domestication, Draught, Drench, Ear, Embrocation, Enteritis, Exercise, Eye, Farcy, Farrier, Fetlock, Fever, Firing, Fomentation, Foot, Founder, Gallop, Glanders, Grease, Grooming, Hide-Bound, Hock, Horse, Inflammation, Influenza, Jaundice, Lungs, Mallenders, Mane, Mange, Mash, Nephitis, Neurotomy, Ophthalmia, Parturition, Peritonitis, Poll-Evil, Quidding, Quittor, Ringbone, Rowels, Sandcrack, Shoeing, Stable, Staggers, Strangles, Tetanus, Trot, Windgalls, and Worms.

HIPPOPHAE. See Buckthorn (Sea).

HIPPURIS,—popularly *Marestail*. A small genus of aquatic plants, of the haloragis order. The common species, *H. vulgaris*, is a curious weed of the ditches, ponds, and other stagnant waters of Britain. Its root is creeping; its stem is cylidrical, smooth, and very succulent, and rises about a foot from the water; its leaves grow in whorls, and are linear, spreading, single, entire, and smooth,—and the lower ones are long, crowded, pale, pellucid, and somewhat deep beneath the water; and its flowers are apetalous, and appear in May and June.

HIRÆA. A genus of ornamental, tropical plants, of the Barbadoes cherry family. Five or six species, all evergreen climbers of from 8 to

12 feet in height, have been introduced to Britain from the two Indias and the west of Africa; and upwards of a dozen more are known.

HIRCINE. A peculiar fatty substance in the fat of goats and sheep. It yields a peculiar acid, called the hircic acid. Hircine, as an epithet, also designates the peculiar odour of the goat. See the article Goat.

HIRCULUS. See Saxifrage.

HIRSEL. A herd of sheep or cattle. The word is Scottish.

HIRTELLA. A genus of ornamental tropical plants, of the cocoa-plum family. Two species, both evergreen trees of between 20 and 30 feet in height, the one violet-flowered and the other white-flowered, have been introduced to Britain from the West Indies; and about a dozen other species are known.

HIVE. See Bee.

HOAR-FROST. A visible lodgment of frozen vapour on the ground. It is always preceded by a comparatively great radiation of heat and rise of vapour; it is most abundant when a considerable degree of cold follows a warm day and accompanies a clear night; and it occurs oftener in autumn and winter than in spring, and abounds most in districts which have a comparatively low average of snow-storms and protracted frosts. Almost all the Scotch farmers and peasantry call it rime. It is well known to inflict great injury on the ripening crops of autumn and the fruit-blossoms of spring in some situations, and to inflict no injury whatever on them in others; and the laws which govern it deserve far more investigation and study on the part of scientific agriculturists than they have yet received. Some principles which affect it are stated in the articles Frost, Cold, Altitude, Atmosphere, Dew, and Draining; but these fall somewhat short of explaining its phenomena, and very far short of fully suggesting the means of preventing it from injuring crops.

An Essay by the Rev. Dr. Farquharson of Alford, in the 14th vol. of the Highland Society's Transactions, records some valuable observations, and throws out some important practical hints respecting hoar-frost; and a digest of it cannot but be acceptable to our readers.—The mean temperature of the day and night at which injurious hoar-frosts may occur, may, relatively to the freezing-point, be very high. Many instances occur of hoar-frost following a day whose temperature is 55°, or a night whose temperature, at half-past 8 o'clock, is about 50°; and extreme cases have been observed of injurious hoar-frosts occurring while a self-registering thermometer, elevated 10 feet above the ground, stood at 39° and 41°, and in weather whose temperature, between ½ past 9 in the morning and ½ past 8 in the evening, had, in a series of days, a minimum of 52° and a maximum of 69°.—Hoar-frost, at a time of a high daily mean temperature, occurs only during a calm; and may be prevented or dissipated by even a very slight breeze.—Hoar-frost occurs only when the atmosphere is very nearly or altogether cloudless; and in many instances in which it occurs under an unclouded sky in the earlier part of the night, it melts away beneath the formation of a close cloud at an advanced part of the night, so as completely to disappear before the rising of the sun.—Hoar-frost most frequently occurs while the mercury in the barometer is at a high point and rising, and while the hygrometer, in reference to the temperature and the season, is at comparative dryness; yet it sometimes occurs in very different conditions of both instruments, and has been observed, in even a very injurious form, when the barometric column was low and falling, and when the atmosphere was damp, and rain fell immediately before and immediately after.—Low and flat lands in the bottoms of valleys and of land-locked basins, generally suffer from hoar-frosts, while the declivities and the exposed summits of hills and other uplands escape injury; and lands upon a somewhat elevated basis, surrounded and overhung by higher lands, without any wide open descent on some side or other, suffer more, under equal circumstances, than hill-locked lands of less altitude.—A very slight inclination of the surface of the land generally protects the crops upon it from hoar-frosts, which inflict great injury on flat and hill-locked grounds; yet, though the slopes of the flanking heights may be quite safe, a slope along the bottom of a dingle or narrow vale or small glen affords no protection.—An impediment of no great height on the surface of a slope, causes damage immediately above it, and in extent proportional to its own height; and a still loftier impediment, such as a dense and tall belt of trees, across the descent or at the bottom of a slope, occasions a proportionally larger extent of injury.—Rivers, though commonly reputed to induce hoar-frost, really tend to mitigate or prevent it; and though, in many instances, they flow through the precise kinds of low, level, hill-locked tracts which are specially subject to it, they either avert or mollify its effects upon the portions of them immediately adjacent to the banks. The protective power of running water is incidentally evinced by the fact, that, in the neighbourhood of waterfalls from mill-sluices, small pieces of potato-ground are free from injury at times when other plots in similar low situations are blackened and more or less destroyed.—Hoar-frost is greatly controlled by comparative wetness or dryness of soil. Many a piece of hill-locked alluvial land, of the kind called in Scotland a haugh, is prevailingly gravelly, arenaceous, or otherwise porous and dry, but is irregularly crossed by bars or belts of clayey, silty, or otherwise retentive and wettish soil; and when a crop of potatoes is growing no such a tract, and a hoar-frost has occurred, the position and extent of the wettish bars are very obviously indicated by the much greater injury which the plants upon them have suffered. The mean temperature of these bars is lower than that of the dry portions; and when the temperature diminishes in hoar-frost, it falls sooner to the freezing-point, and continues a longer time beneath that point, on the wet soil than on the dry.

Hoar-frost produces peculiar currents in the atmosphere; and, though apparently capricious, is always governed by uniform and stable laws. On flat lands and in hill-locked hollows, no hoar-frost currents occur at all discernible by feeling; but on sloping lands, a very sensible and steady current, though generally but a feeble one, toward the most direct descent of the slope, is rarely absent. "After many years' observation," says Dr. Farquharson, "we can state it as a proposition uniformly true, that, at night, under a clear sky, and with a dead calm in the valleys, there is a downward current of air on the sloping lands, to whatever point of the compass the descent of the land may be directed. * * The cold first takes place on the surface of the ground; and the lower stratum of air becomes cooled, and descends to a lower temperature than that of the air immediately above, by contact with it. By its cooling, the lower stratum acquires a greater density, and cannot rest on an inclined plane, having no air of equal density and at the same level, to balance it over the bottoms of the valleys, but begins to run downward in the direction of the steepest descent, increasing its velocity in proportion to its lower temperature, and consequent greater relative density. Its place, at the summit of the slope, is supplied by warmer air from above coming directly into contact with the cooling ground, and preventing it from getting so low as the freezing temperature, at those seasons when the mean temperature of the day and night is much above the freezing point. This process is continually renewed so long as the temperature of the ground is descending. Lower down on the slope, the current of air is creating perpetual eddies that mix the lower stratum with the strata of warmer air immediately above, and greatly modify the diminution of heat close at and on the ground; while towards the lower end of the slope, the lower cooled stratum runs quite off, to find rest in the bottom of some hollow, or on some flat land. When the mean temperature is high, these currents on the sloping lands take place long before the lower stratum has descended to freezing, and may be often experienced immediately after the going down of the sun. In such cases, no freezing occurs on these lands at all. But when the mean temperature of the day and night is already low and wintry before the occurrence of a calm and clear air, the lower stratum may be reduced to the freezing point before it attain such a high density, in comparison with the mass of the atmosphere, as to give it a downward motion on the slopes, in which case the crops on the sloping lands and uplands are injured as well as those on the low grounds.—On the flat grounds and hollows, also, the coldness of the earth during hoar-frost is communicated to the air in contact with it; but the air, although thus rendered denser, has, from its position, no urgency in its increased gravity to any lateral movement, much less to any mixture with the warmer air above. Its comparative gravity keeps it close at the ground, of which the diminution of temperature is not therefore modified by a mixture of any of the warmer air above. Under the continuance of this condition of matters, both the surface of the ground, and the air in immediate contact with it, descend to or below a freezing temperature. The cold dense air remains settled on the place like a lake, which hourly becomes deeper, both by the increasing cold of the ground, and the descent to it of cold air from the neighbouring heights. If at this time the hygrometer indicates a very dry air, no other deposition of moisture from it takes place than what forms the minute icy spiculæ, peculiarly named the hoar-frost, on the soil and plants. If the hygrometer indicates damp in the air, a mist is formed at the surface of the ground, which, in proportion to the degree of damp, shows itself earlier or later as the temperature descends toward, or reaches, or passes, the freezing point. The mist, named provincially the frost-fog, is generally coextensive with the ground on which the frost inflicts the injury, but may extend beyond it when the air is very damp, or be much more confined, and limited to the lower depressions in the hollows, a case of more frequent occurrence when the air is very dry. The frost-fog very frequently gives opportunity to ascertain by the eye the peculiar settledness and calmness of the air within hollow grounds on occasion of hoar-frosts,—a settledness often continuing for hours, and which is explained by the relatively higher density of the air pressing it down into the hollows. This is its most frequent behaviour; but we must not omit to notice, that sometimes after it has attained a considerable depth, we have seen it under the influence of a rising breeze from one side, shift in a great measure in an unbroken state, to the opposite one, and thus inflict injury considerably higher up on one side of a valley than on the other."

The injurious effects of hoar-frost might be mitigated or prevented, on many sloping grounds, by removing such woods and high fences as intercept a free descent of currents of air; in gardens, by selecting the site of them on a gentle slope, and leaving one entire side sufficiently free from any lofty fence or shelter to allow the escape of the heavy air on the surface of the ground before it chills down to the freezing temperature; and in low, flat, hill-locked tracts of land, by producing an artificial current in the lowest strata of the atmosphere upon them during the prevalence of a hoar-frost. The last of these cases is the most difficult; yet is far from being impracticable by economical means. A stratum of air 20 feet thick is no heavier than a stratum of water about three-tenths of an inch thick; and, even though it should extend over a comparatively large tract, it consists of so exceedingly unstable a fluid as to be very easily disturbed and kept in motion. Any machinery expressly for the purpose, no matter how simple and cheap, cannot, in the present state of things, be successfully recommended; for most farmers would pronounce it an implement fitter for Utopia than for the actual world, and even the wisest might hesitate to incur the derision of their neighbours by setting up a standing remedy for an evil which is only contingent, and does not occur every year. "But," says Dr. Farquharson, "we cannot refrain from pointing to a source already existing in sufficient abundance on every farm, to allow the power of all the horses upon it to be directed to the agitation of the atmosphere in any locality, with a very small additional expense. It is found in the farm-carts; where a temporary sheave, capable of removal, fitted upon the nave of a wheel, might, by means of an endless rope or chain, turn a revolving body like the fly of a barn-fan, but of much larger dimensions, turning on a horizontal axle passing through two upright posts secured to the body of the cart. A cart fitted with this apparatus, and travelling over the roads of a farm, would obviously mix to a greater depth the upper and lower strata of air." A fan of the same kind, turned by water if it can be commanded, might avert the mischiefs of hoar-frost from the fruit-blossoms and delicate blossoms of any garden which has no slope or opening to allow the frozen vapour to run off.

HOCK. The joint of the lower part of the hind-leg of a horse, an ox, or other quadruped, corresponding somewhat to the knee of the fore-leg of the same animal, and to the ankle of the human being. In the horse, it is an important joint; and greatly contributes, by the peculiarities of its individual conformation, to the comparatively high or low value of the animal; and is frequently the seat of disease and of seemingly unaccountable lameness. The chief diseases to which it is particularly subject will be found noticed in the articles CURB, BOG-SPAVIN, BONE-SPAVIN, CAPULET, and MALLENDERS. But another disease of it, not noticed in any separate article, is a general sprain of the whole joint, called, from one of its most visible consequences, enlargement of the hock. This is caused by overburdening, by a sudden check at full speed, or by a smart concussion; it involves lameness, inflammatory action, and excessive local sensitiveness; and it is speedily followed by swelling and perhaps permanent enlargement. The remedies are rest, fomentations, and, in a very bad case, firing; but these frequently fail to do more than reduce the inflammation and cure the lameness. A horse with a permanently enlarged hock, is weaker in that joint than in others, and, if required to perform hard work, is unsound; yet he may be as good as any other horse for light or ordinary work; and is liable to fail and become lamed, only when obliged, in any instance, to exert a degree of strength beyond the capacity of his weak hock joint.

HOE. An implement for performing the operation of hoeing. This operation has great diversity of character and object, and occasions a correspondingly great variety in the structure and working of hoes.

Hoeing, on the largest scale, and with the widest scope, is a course of tillage, or of cleaning and pulverizing, in the intervals of the rows of growing crops; it constitutes a main part of the after-culture of all field crops raised in drills; and it contests with the drill system the honour of giving name to the modern system of cleaning and pulverizing which was introduced by the celebrated Tull, and which hence was called by Tull himself the horse-hoeing husbandry. The chief implement in this kind of hoeing will be noticed in the article HORSE-HOE; yet the horse-hoe cleans only the clear intervals between the drills, and requires to be followed by the hand-hoe, for removing the weeds from among the drilled plants themselves.

The common hand-hoe is employed in the field for cleaning, after the horse-hoe, among turnips, potatoes, ruta-baga, and beans,—for cleaning the intervals between drilled crops, such as those of corn, whose rows are too close to admit of the use of the horse-hoe,—and for singling out, at proper and equal distances, the plants of sown turnips and ruta-baga which are intended to remain for a crop. But the various hand-hoes of gardens and of the home-farms of parks, are employed for loosening weeds or thinning out cultivated plants, in such a way that the dislodged stems and roots may either be picked up, or raked off, or die in consequence of losing radical connexion with the soil,—for stirring, softening, and pulverizing the soil, so as to promote its aeration,—for drawing up soil around the stems of cultivated plants, in order either to multiply their spongioles, to increase their stability, or to blanch their lower portions,—and for forming drills or small, hollow, linear ruts in the soil, preparatory to the sowing of rows of seeds. Some other but less common purposes, also, are sought, —such as the removal of young moss-plants from nursery beds, the removal of lichens, hepaticæ, and fungi from trees, the cleaning of neglected gravel-walks, the weeding of hedges, and the scarifying of the soil in wide intervals between drills of growing plants. Most hand-hoeing operations must be performed when both the ground and the weather are dry; and a large proportion of them are widely different from one another as to at once time, conditions, and the most suitable variety of tool.

Hand-hoes are so well-known implements, and include so very many varieties, and in a certain degree are so controlled by fashion, that we need not notice all. The common draw-hoe has simply a plain blade or plate adjusted at right angles to the shaft; and is exceedingly diversified in both the absolute length and the comparative depth of the blade. Good kinds of it may have plain four-cornered blades of any length, from two to twelve inches, according to the nature of the work to be done, and particularly according to the required distances of the plants in the operation of singling, and the comparative looseness or adhesiveness of the soil in the operations of cleaning, stirring, and pulverizing. Yet in consequence of the wedge being narrow, a hoe with a curved blade always does its work more facilely than a hoe with a straight blade. A superior variety of hoe for operating on very stiff soils is furnished with a prong or prongs on the side opposite to that of the blade; so that whenever a refractory clod is encountered, the hoe can be whirled round and made to work first with the prong and next with the blade.

A large portion of the agriculture of France alternates with a sort of garden culture so as to involve a very large aggregate of hoeing; and the chief part of all the tillage and other soil-operations of the vineyards consists of hoeing; so that the French are remarkably skilful in the use of the hoe, and possess some curious and many valuable varieties of the implement. "The hoe," remarks M. Thouin, "is an implement of universal use; and by it the surface of the soil can be stirred to the depth of from 3 to 7 inches, at less expense of time and human strength than by any other manual implement whatever. It is among manual implements what the plough is among implements drawn by cattle. Pronged hoes are particularly suitable for gravelly, stony, and clayey soils, and those full of root-weeds; but, in any soil, they require less strength on the part of the operator than common hoes." A very favourite French hoe is pronged and heavy, and requires the person operating with it to stoop very low, and occasions him more labour than the use of the spade, and tends, when much employed by one person, to induce upon him anchylosis of the spine and permanent stooping and deformity. Another French hoe is like a one-sided pick-axe; another, like a curved wedge; another, like a double-wedge or an indented blade; another, like a curved adze; another, like a double and opposite-faced adze; another, like a combination of the adze and the pick-axe; and others have forms different from all these and from one another.

Some British agriculturists have recommended the heavy hard-working French hoe; some, the common draw-hoe, furnished at the back with a prong or prongs; and some, the forked hoe or hoe with deep and indented blade; and one distinguished agriculturist recommends a hoe of two mutually disjoined and considerably-separate blades, for cleaning both sides of a drill at one operation,—another of three mutually disjoined but not distant blades, for singling plants,—another of three arched and mutually disjoined blades for forming drills by drawing,—and two others, of equally peculiar form, for other and different purposes. A hoe invented by John Booker, Esq. has so peculiar a construction as to cut well in any direction,—backward, forward, or to either side; yet cuts best when moved diagonally backward and forward; but it does not remove much earth, and is most suitable for mere cleaning operations in the intervals between garden drills.

The Dutch hoe has a variety of forms; but, in all instances is a push-hoe and not a draw one. It is peculiarly suitable for skimming the surface of soils, cleaning neglected loose garden walks, cutting the weeds at the root of trees and hedges, and every other kind of operation which stirs the soil not more than an inch deep.—The thrust-hoe also comprises some varieties; but, in a general view, differs from the Dutch hoe in having a sharp edge in the rear as well as one in the front, and usually in having the front-edge of an angular outline.—The Spanish hoe has a pointed tongue-shaped blade, projecting from a small arched bar, and adjusted at right angles to the shaft; and is usually made of different sizes, the larger for planting or transplanting, and the smaller for hoeing among plants.—The Jersey hoe has an iron ring adjusted on the same plane as the shaft, and a small curved blade projecting at right angles from the remote side of the ring; and is better suited for scraping parasitic cryptogams from trees than for operating upon soil.—The pick hoe, the Sarthe hoe, the Grenoble hoe, and several of the French hoes have variously framed prongs, and are all more or less fitted to do work in the garden analogous to that which grubbers do in the field.

HOEING. See Hoe.

HOEING-MACHINE. See Horse-Hoe.

HOG. A genus of quadrupeds of the pachydermatous order. The generic characters are four or six incisors in the upper jaw, converging; six in the lower jaw, projecting; two canines in the upper and two in the lower jaw, very long; fourteen molars in each jaw; the snout prominent, truncate, and containing a peculiar bone; feet, cloven.

The Common Hog and its Varieties.—The common, well-known, and generally diffused species, *Sus scropha*, comprises the wild boar, the Chinese hog, and all the varieties and breeds of the domestic hog. The wild boar is the type of this species, and has a short and thick body, black and bristled hair, straight ears, and prismatic tusks which curve outwards and slightly upwards.

The aboriginal hog of England, Wales, Scotland, Shetland, Orkney, and Ireland, seems to have been very little diversified by climate, and not diversified at all by the influences of domestication. The hog of all parts of the territories which now constitute the United Kingdom, was for a long time wild; it was then, for a long time, but very rudely, domesticated; and it continued, till a comparatively recent period, to be quite unaffected by the niceties of modern improvement. The Wild Boar's Fell in Cumberland, and several other wild tracts of land in Britain, acquired the names which they still bear from being long the haunts of the untamed boar. Mr. Whittaker, in his History of Manchester, states that the wild boar roved over the woods of the parish of Manchester during many centuries after the departure of the Romans, that it gave the name of Barlow or boar-ground to a tract in the south-west of that parish, and that it retained its haunts in the wilds of Blakely till within the last three or four ages. Fitzstephen, in his Description of London, written in the latter part of the 12th century, states that boars were among the wild animals which frequented a forest then surrounding the city; and other authorities mention that the boar, till quite a recent period, continued to scamper at will throughout parts of the New Forest in Hampshire, and in several other extensive hunting-grounds in both England and Scotland. The flocks of swine which belonged to our rude ancestors of the middle ages, were in a state but a degree or so better than absolute wildness; and the swine-herds who looked after them were so singular a class of men, and lived so constantly among adventures, that they figure in legend and romance nearly in the same wild and wondrous manner as their contemporaries, the Knights-errant. Dr. Hibbert, in a paper in the Transactions of the Antiquarian Society of Scotland, furnishes the following curious notice regarding the domesticated possession of swine on a manor in Lancashire in the third decad of the 16th century:—"The swine of the lord of the manor's tenants were allowed to range in the demesnes of the town from the latter end of August until sowing time, provided that they were properly ringed and did no harm; in default whereof, the owner was to loose him to the lord 4d. or by this sum redeem him from poindage. The brewer who brewed to sell, and the miller, were allowed to keep three swine; the tenants who had land in the fields, two swine; and he who held no land might have one swine." Some very curious laws, likewise, are on record for regulating property in swine during the middle ages; but neither they nor the other documents afford a hint that any such distinctions among swine were then known as are now called breeds or varieties.

The hogs which are still most common in the Highlands and Western Islands of Scotland may probably be regarded as the least altered descendants of the swine of the ancient Britons. They are very small in size, and neither white nor yellow, but of a uniform grey colour, and have a shaggy coat of long hairs and bristles. They wander and feed on the hills in the same manner as sheep; and live all the year round on roots and natural herbage, and without any artificial shelter. Mr. Culley says, "They are a small thin-formed animal, with bristles standing up from nose to tail, and exceedingly bad thrivers. We met with considerable herds of them upon the moors in different parts, picking up the wild berries, especially about Thurso in Caithness." But when driven to the Lowlands, they readily fatten, and attain a considerable bulk; and even among their native moors and mountains, without the aid of any artificial feeding, they get into good condition and yield excellent pork in autumn.

The Shetland hog is a small, ill-shapen, brindled, disagreeable-looking animal, the very beau-ideal of one of the ugliest and least tameable of the wild boars, yet scarcely larger than an English terrier. It has either a brown, a black, or a dunnish-white colour, a remarkably strong nose, sharp-pointed ears, and an exceedingly arched back, clothed with long, stiff, erect bristles. It is often very lean, but readily admits of being artificially fattened; and its pork, in the former case, is proportionally coarse,—but, in the latter, is sweet and delicate, and may be cured into excellent hams and bacon. It very generally roams unrestrained, and roots up potatoes, turnips, corn, and other field crops, and makes war on some kinds of its fellow-animals, and, so far from being a profit to the community, is a devastator of the country and a common pest. "This lordling of the Shetland scatholds and arable lands," says Dr. Hibbert, "ranges undisturbed over his free demesnes, and, in quest of the roots of plants or of earthworms, hollows out deep furrows and trenches in the best pastures, destroys in his progress all the nests which he can find of plovers, curlews, or chalders, and bivouacs in some potatoe-field, which he rarely quits until he has excavated a ditch large enough to bury within it a dozen of fellow-commoners of his own size and weight. Nor is the reign of the petty tyrant altogether bloodless: when a young lamb is just dropped, it is then that he foams, and, as Blackmore has pompously sung, 'flourishes the iv'ry war,' never quitting his ground until the grass is tinged with the red slaughter of his victim."

The Orkney hog is very small in size, and seldom weighs upwards of 60 or 70 pounds. Its colour is variable; its nose is exceedingly strong; its ears are erect and sharp-pointed; and its back is clothed with long bristles. It roams on the moors in the manner of the Highland hog; and commits depredations in a similar style to the Shetland hog; and is far more mischievous on arable lands than even the largest kinds of English hogs. It yields passably good pork when killed fresh from the moors; and is capable of being fattened and sweetened into excellent material for hams and bacon by artificial feeding. Its hair, though short, is fabricated by the natives into ropes, which serve better than the strongest hempen ones for the perilous purposes of suspending the gatherers of sea-fowls' eggs on the cliffs and beetling precipices of the mural coast.

The old hog of the southern parts of Scotland and of almost all parts of England, passes up by numerous and nearly imperceptible gradations from the small aboriginal hog of the Scottish Highlands to an animal of much larger size, but generally quite similar to it in configuration and habits. Its shape is lumpish, uncouth, and wildly coarse; its bones are comparatively large; its ears are large, long, flapping, and pendulous; its nose is long and powerful; its shoulders are low; its back is arched and narrow; its limbs are long; and its colour is considerably diversified, but in general is either whitish throughout or whitish spotted with black. It is a prolific breeder, and often attains a huge size when judiciously managed from the outset, and fattened at the age of two or three years; yet it is constitutionally lank, lean, hungry, and voracious,—consuming enormous quantities of food, very slowly accumulating flesh or fat, and making miserable compensation in the bulk of its pork for the bulk of its provender. But both this large animal itself, and the many gradations of the descendants of the aboriginal British hog intermediate between it and the ugly, wild, grinning dwarfs of the Scottish Highlands and Islands, have everywhere become uncommon in their unmixed or characteristic state, and in many districts have been either obliterated by bold and long-continued crossing, or exterminated by the universal adoption of better breeds.

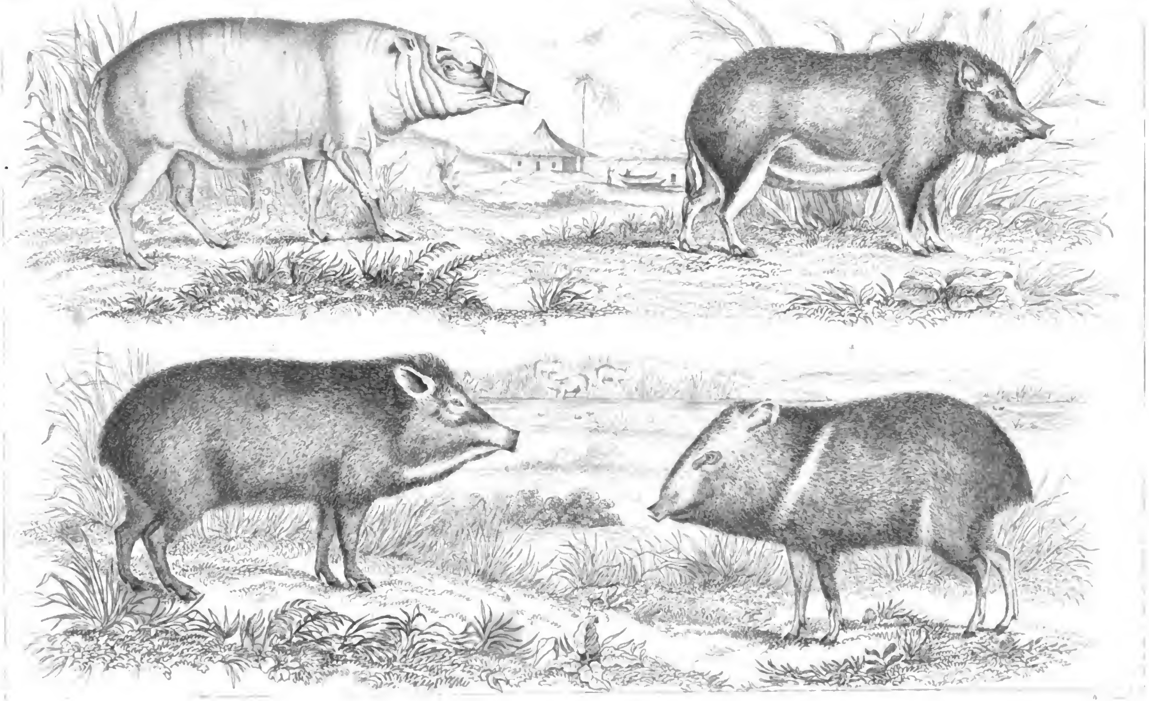
The old Irish hog closely resembles one of the worst specimens of the large old British hog. It is ugly, bony, razor-backed, lank, large, coarse, greedy, a voracious eater, a most unkindly feeder, and exceedingly difficult to fatten; and even in its best state, it yields pork and bacon far inferior to those of almost all the improved breeds. Its best recommendation is, that it has disappeared from all the comparatively enlightened parts of Ireland, and is rapidly disappearing from even the remote and most neglected districts. Yet, with unutterable absurdity, it is still preferred to every other hog by a few of those half-mad antiquity-loving peasants who can see nothing but horror and ruin in any kind of deviation from the practices of their fathers.

The Chinese hog, represented in *Figure* 2, *Plate XXXVII.*, has been a main source of the variations and improvements in the modern breeds of British swine. The type of it occurs in Siam, and in the regions immediately adjacent to that country; and, though generally called Chinese by Britons and Americans, is more properly called Siamese by the French. Its length of body is 3½ feet; its length of tail is 9 inches; and its height at the shoulder is 20 inches. Its eyes are surrounded by a slight tinge of flame-colour; its ears are short, straight, and flexible; its skin, except on the belly, is black; and its hair is soft and somewhat silky on the body, stiff and thick on the head and back of the neck, frizzly on the cheeks and under-jaw, thin on the other parts, and generally hard and black.

The typal or strictly pure Chinese or Siamese hog is too delicate in structure and tender in constitution to be adapted to countries very different in climate from Siam; but subvarieties of it, and crosses from it, are distributed throughout the Indian Archipelago, some of the islands of Polynesia, many of the eastern and central parts of Asia, and even far-distant parts of Africa; and several or even many of these have, in modern times, been introduced to Australia, to America, and to Europe, and have very powerfully corrected the bad properties, and improved the good ones, of the aboriginal hogs of Britain, and of other domesticated descendants of the wild boar of Europe. Three very distinct subvarieties of the Chinese hog have now for a long time been in Britain,—the black, the white, and the tawny; but Mr. Culley enumerates seven; and any rigid systematist, who should reckon not only pure oriental crosses, but mixtures of these with the British breeds, might probably reckon up a good many scores. But all the real Chinese in Britain may, far more conveniently, be described as strictly one variety, diversified in colour, sometimes white, sometimes black, sometimes irregularly patched with black and white, frequently dark grey, and occasionally of a sandy hue,—some better shaped than others, some hardier, and some more prolific,—but all compact-bodied, well-formed, small-limbed, thin-eared, small-headed, thick-necked, thin-skinned, and with the head so adjusted to the body that, when the animal is fattened, the whole snout except the extremity looks as if absorbed into the body. The Chinese hog is not easily reared, and seldom attains a greater weight than from 10 to 12 stones at the age of one year, or of from 16 to 18 stones at the age of two years. Its flesh is delicate and very excellent; yet is disliked by some fastidious persons on account of the animal's being so easily fattened.

The cross-breeds between the Chinese hog and the aboriginal British hog—particularly such as largely retain the British character—may be described as combining much of the size, most of the adaptations, and all the hardiness of the aboriginal British with a large proportion of the fine form, quiet disposition, kindliness of feeding, aptitude to fatten, and delicacy of flesh of the Chinese. "By a mixture of the Chinese black swine with those of the larger British breeds," says Mr. Wilson, "a kind has been produced possessing qualities superior

HOGS



to those of either of the parent stock. They are extremely prolific, are sooner fattened than the larger kinds upon a more slender supply of provisions, and they cut up when killed to more useful and convenient portions. Another breed which may be classed under this head, was introduced into this kingdom about the beginning of the present century. It was produced from an emancipated wild boar brought from America, and a sow of the improved Chinese breed. It is extremely prolific, and the colour of the pigs is highly diversified. Some are striped longitudinally with brown and black, others with black and blue, or black and white. The original boar was of a rusty brown colour. The finest of the Chinese breed are remarkable for the delicacy of their appearance, for their thin transparent ears, their small head, and short but slender legs. They are perhaps too small for bacon; but for roasting-pigs and the most delicate pork they stand unrivalled. The larger sort, which weigh 10 or 12 stones when about a year old, and have therefore a strong cross of the native breed, are recommended as very suitable for arable farms, where their provender is picked up chiefly in the fold-yards."

The Berkshire hog is one of the most distinguished of the somewhat pure English breeds, and has long been very generally distributed through the greater number of the good hog-feeding districts of England. The original breed, or the hog whence the present breed sprang, was large in bulk, great in length, thick, long, and not proportionally deep in the body, short and very bony in the legs, heavy and ill-shapen in the ears, somewhat crooked in the snout, generally a slow feeder, but always capable of attaining a very great weight. It was improved, in the first instance, by crossing with the wild boar,—next, by frequent and judicious crossings with the best extraordinary specimens of its own variety,—and next, by limited crossing with the Chinese breed; and, according to the opinion of very many professional hog-feeders, it requires to be crossed every sixth or seventh year with the Chinese breed, in order to prevent its degenerating in both the goodness of its form and the excellence of its flesh. The improved or modern Berkshire hog is shorter in the body, longer in the leg, lighter in the head, and less voluminous in the bone, than the original hog. It has in general, a reddish, rufous-brown, or tawny white colour, spotted with black or brown. Its coat is coarse and curly, and quite out of character with the comparative fineness of both the skin and the flesh; its body is thick, compact, and well-formed; its legs, notwithstanding their being longer than those of the unimproved hog, are still short; its head is well-poised; and its ears are large, and sometimes hang over the eyes, but generally stand somewhat forward. It fattens with comparatively great rapidity; but though both hardy and very thriving when well kept, it very speedily loses condition or declines into a bad state when ill fed. It usually attains a very great size, and averages a weight of from 50 to 60 stones; and, under good management and other favourable circumstances, it occasionally attains the enormous weight of from 90 to 100 stones, or even a little more. A Berkshire hog, fed long ago by Mr. Lawton of Cheshire, measured 9 feet 8 inches from the nose to the end of the tail, and 4 feet 5½ inches in height, and weighed, when alive, 12 cwt. 2 qr. 10 lb. The improved Berkshire breed yields exceedingly fine bacon; and is altogether one of the most important breeds in Britain.

The Hampshire hog is very large in size; it is longer in the body and the neck than the Berkshire hog, but is not so compactly formed; it has, for the most part, a white colour, either uniform or spotted; and it fattens well, attains a large bulk, yields excellent flesh, and is well suited for large bacon and hams.

The Sussex hog attains, at full growth, an average weight of from 18 to 20 stones. It is readily distinguished by the peculiar markings of its colour; for it is commonly black and white but not spotted, or frequently black at both ends and white in the middle.

The old Essex hog is a great eater and a ready fattener, but has a restless disposition, and often consumes more than it is worth, and has gone quite out of repute. Its colour is either white or black and white; its coat is very bare; its head is long and sharp; its body is long and flat; its back is roundish; and its bones are somewhat small.

The modern Essex hog, or Essex half-black, is a descendant of the Berkshire hog, and was introduced to Essex by the late Lord Western. Its colour is black and white; its coat consists of short hair; its skin is thin; its nose is short and snubby; its head and ears are not so large as those of the Berkshire hog; its body is broad and deep; its hind-quarters are ample and fleshy; and its bones are comparatively small and fine. It grows rapidly, fattens well, and yields prime material for hams and bacon; and it has come into high repute, and now ranks with the Berkshire hog as one of the best breeds in Britain.

The Cheshire hog frequently attains a gigantic size. Its colour is sometimes entirely white, but more commonly a mixture of large patches of white and black, or of white and blue; its skin is loose; its bones are large; its legs are long; its head is large; its ears are very long; and its body is extremely long, but is narrow in proportion to its other dimensions.

The Shropshire hog is large and coarse. Its colour is white, with black and sometimes sandy patches; its bone, hair, and bristles are superabundant; its coat is harsh and almost wiry; its head is coarse, sharp, and long; its ears are large; its body is deep and flat; and its legs are long, firm, and not very symmetrically set. It is neither so well-formed, so easily fattened, nor so economically fed as the Berkshire hog; and yet it has long been held in estimation by distillers, and other parties who can afford it a profusion of food; and it very commonly attains a weight of between 40 and 50 stones.

The Rudgwick hog is the largest in Britain, and is reared around the village of Rudgwick on the borders of Sussex and Surrey. It often attains a prodigious size; and, at two years of age, sometimes weighs twice as much as almost any other kind of hog of the same age. It thrives and fattens without any special care; it probably has, at two years of age, an average weight of 70 or 72 stones; and it is peculiarly suitable for such hog-feeders as can give their swine but second-rate attention, and are anxious for large bulk and weight without being equally solicitous for prime quality of flesh.

The Woburn hog is well-formed, large, and very prolific. Its colour is generally a white or whitish-brown, marked with spots of different hues; its head is small; its body is rounded; and its limbs are small. It grows rapidly, fattens well, and has the reputation of being a more economical feeder than most other varieties of hog. It was introduced by the late Duke of Bedford.

The Northampton hog is a well-formed, deep-sided, middling-boned animal, formerly second in request in the midland counties to only the Berkshire and the Shropshire hogs, but now very generally supplanted by the Dishley or New Leicester breed. Its colour is white; its size, especially the subvariety of it formerly bred about Naseby, becomes enormous; its legs are very short; and its ears are much larger than those of the Shropshire hog, and sweep along the ground, before its nose, and almost blinding its eyes. Its disposition seems to be unusually gentle.

The original Leicester hog has a light-spotted colour, well-formed head and ears, and a large, deep, flat-sided body. The Dishley variety was reared by the celebrated Bakewell; and has acquired the fame, not only of being an excellent kind of hog in itself, but of forming a good source of general improvement by crossings with other breeds. It is fine-boned, clean-shaped, and of neat and almost elegant appearance; and, when full-sized and well-fattened, it seems almost a ball of meat, as thick as it is deep, and as deep as it is long, its belly nearly touching the ground, and its eyes and snout looking as if they were almost absorbed into the body. It has a larger proportion of flesh in comparison to its bone and its offal than probably any other variety of hog; and yet it is slow of growth, and somewhat tender in constitution, and requires much food to make it fatten; and it possesses the additional disadvantage of not being so prolific as most other breeds.

The Norfolk hog is hardy and prolific, and can be easily and greatly improved by crossing, but is otherwise of inferior character. Its colour is either white, striated, bluish, or of other hues and variegations; its skin is thin; its ears are short; its body is small; and its flesh serves better for pork than as material for hams and bacon. The offspring of a cross between the Norfolk breed and either the Berkshire or the Dishley hog possesses a good aggregate of valuable properties.

The Suffolk hog is a small and somewhat delicate animal; and attains an average weight of from 16 to 19 stones. Its hair is short and very bristly; its forehead is broad; its back is narrow; its belly is pendent; its legs are high; and its general form is more puggish than that of the Norfolk hog. It seems to possess a large intermixture of the white Chinese breed, and has been, for a considerable period, in somewhat high estimation; yet it eats a comparatively vast quantity of food, and is by no means a kindly or economical feeder.

The Wiltshire hog was formerly in some request; but has been, in a great measure, obliterated by crossing with the Berkshire and other breeds, and succeeded by a variety of smaller size and better properties of flesh and feeding. Its colour is light; its bone is round; its ears are pointed and of medium size; and its body is long and low, with a depression at the shoulders, and an elevation at the rump.

The original Yorkshire hog is a large animal, and probably the very worst of the large hogs of Britain. It has the advantage of being a more economical feeder and a more rapid fattener than some of the better varieties; but it thrives ill in the sty during winter, and it is always long in the legs and weak in the loins, and frequently feeble or positively unsound in constitution.

The Herefordshire hog is a descendant of the Shropshire hog; and is large in size, and tolerably good and eligible in aggregate properties; yet it cannot bear comparison with the Berkshire hog, and does not possess any peculiar recommendations.

The Gloucester hog is generally white; it has two wattles hanging from the throat; and it is long, tall, and of large size. But it is inferior both in form and in aggregate properties, not only to the Berkshire hog, but also to the Shropshire and the Hampshire hogs, and to some other large breeds.

The original Lincolnshire hog has some resemblance to the old Northampton hog. Its colour is white or lightish; its coat is curly and has a somewhat woolly appearance; and its body is of medium size. This breed thrives well when young; but is much inferior to some other breeds for the purposes of thorough-feeding, and of conversion into bacon and hams.

The small, white English hog occurs in many districts, and is particularly abundant in the northern counties. Its colour is white; its head and neck are well-formed; its ears slouch somewhat downward; its body is thick, compact, and well-shaped; and its legs are short.

The Lowland Scottish hog was, at a recent period, very general throughout the southern half of Scotland; but is now, in a main degree, obliterated and supplanted by crossings with the Chinese and the English breeds. It is, when unimproved or even when not much altered by crossing, a very unprofitable animal. Its colour is a dingy white; its legs are long; its body is comparatively light and narrow; and its ridge, from nose to tail, is surmounted by a range of erect bristles.

The swing-tailed hog is a useful variety of the smaller class of swine; it has much weight proportionately to its size; and it is quite hardy in constitution and in habits of feeding.

The Tonquin or Tonquey hog is a cross-breed between the Chinese and the Berkshire varieties; it possesses sufficiently distinctive and steady characters to occupy the rank of an independent breed; and it has many excellent properties in itself, and also serves well for improving some other breeds by crossing.

The black hog of the south-western parts of Continental Europe is a native of Africa, and was formerly common in many parts of France, and is still common in Italy and Spain, and was, a considerable time ago, introduced to South America, and has there increased and spread into a surprisingly multitudinous and far-extended race. It has a coat of rather fine hair; it grows rapidly; it does not fatten well, but is by no means fastidious as to either food or treatment; and, when kept upon the banana and ultimately fattened with maize, it yields excellent flesh.

The French varieties of the hog, common in the time of Buffon, were generally bad; and even most of those of the present day, in spite of many changes and some improvements, are far from being good. The old hogs of Vivarais and the north of France were white, and those of Dauphiny, Languedoc, and Provence were black. The present hog of the Pays d'Auge attains the weight of 600 lbs., and has white, coarse, sparse hair, small bones, a small and sharp-pointed head, narrow and pointed ears, a long body, and strong and broad legs. The present hog of Poitou attains a weight of not more than 500 lbs., and has coarse bristles, large bones, a long, thick, pointed and projecting head, large and pendulous ears, a long body, and broad and strong feet. The present hog of Perigord has black hairs, a thick and short neck, and a broad and compact body; and, by crossing with other breeds, has produced the pied swine which are so common in the south of France. The present hog of Champagne has white hair, broad pendent ears, a large body, and flat sides, and does not fatten well. The present hog of Boulogne is a cross between the Berkshire hog and one of the common old breeds of France; it is generally white, and has very broad ears; and it fattens rapidly and well, and attains considerable size and weight. The hog known in France under the name of Porc de Nobles appears to have been derived from the breed which was obtained in England by crossing an Anglo-Chinese sow with an emancipated American boar.

The Jutland hog has large and pendent ears, an elongated body, a somewhat curved back, and long legs; and it attains so considerable a size as to yield, in its second year, from 200 to 300 French livres of lard. This breed makes a considerable figure in commerce.

The most peculiar and characteristic of the several Swedish varieties of the hog, is supposed to contain a cross of the wild boar, and has a broad head, an upward-turned snout, very erect ears, a long body, and long legs.

Most of the hogs of Poland and European Russia have a reddish or yellowish colour, and are small in size.

The Zealand hog is a cross of some native breed with the Chinese hog; it has erect ears, a short body, a strongly bristled back, and a small tail; and it attains, about the end of its second year, a weight of from 160 to 240 lbs.

De Witt's hog is also a cross between some native breed and the Chinese hog; it is somewhat larger than the Porc de Nobles; and it fattens easily, and is very productive. Its colour is white; its coat is thick on the upper part of the neck, but much thinner on the back; its head is straight and fine; its ears are of medium size; its neck is thick and round; its shoulders are broad and strong; its flanks are broad; its back is straight; its croup is long, broad, and rounded; and its legs are short.

The hogs of the east of Europe are remarkable for their size; and have a deep grey colour, and very long ears; but they are comparatively unprolific,—a sow of the breed having seldom more than four or five pigs at one farrowing.

The Westphalian hogs resemble the hogs of the east of Europe in size and general appearance, but differ widely and advantageously from them in prolificity, every sow having generally from ten to twelve pigs in a litter.

The hogs of Bavaria are remarkable for the smallness of their bones, and for the readiness with which they take on fat.

The smooth or short-legged hog occurs in Spain, Portugal, Savoy, and the north and south of Italy; and is the porker from which the original well-known Bologna sausages were prepared. It is a descendant of the Chinese hog, and continues to be closely allied to that animal. It is of small size, and very productive, and fattens to so enormous a degree that its belly sometimes trails upon the ground. Its colour is commonly coppery, but sometimes a bright fiery red; its bristles are short and slender; its skin is very thin; its head is unusually short; its jaws are thick; its forehead is stunted; its frontal skin falls in folds above the eyes; its ears are short, pointed, and almost erect; its neck is thick and strong; its chest is very vigorous; its body is round and long; and its legs are short and strong.

The Turkish hog prevails throughout European Turkey, and occurs as far north-west, within the Austrian dominions, as the vicinity of Vienna. It fattens in half the time of many of the common breeds of Europe, and attains a weight of from 300 to 400 lbs. Its coat, when young, varies from whitish-grey to brownish-red, and is marked with blackish bands along the dorsal portion of the sides; and, when old, consists of slender frizzled bristles, of a grey colour, more or less deep, rarely black, and still more rarely of a reddish-brown. The ears of this animal are straight and pointed; its legs are short and firm; and its body is scarcely longer than high.

The Neapolitan hog has recently obtained some repute in the north-west of Europe as a profitable source of crossing with other breeds; but, in itself, it wants hardiness of constitution, and is quite unsuitable for less genial climates than that of the south of Italy. Its coat is thin; its colour is dark or blackish; its size is small; its tendency to fatten is keen and rapid; and its flesh is delicate and generally excellent.

The Maltese hog was formerly in great request in Britain, but has lost much of its celebrity. It is black, thinly-coated, small-sized, of great aptitude to fatten, and otherwise closely allied to the Neapolitan hog.

The Cape-of-Good-Hope hog not only occurs in Southern Africa, but has been extensively propagated in Australia and several parts of South America; it is a subvariety of the pure Chinese or true Siamese hog, but somewhat smaller, and probably originated in India; and, according to Desmarest, it is nearly identical with the breed of the South Sea Islands. Its colour is black or deep chestnut; its hair is hard and thinly scattered; its ears are straight; and its tail is pendent, and terminates in a tuft of bristles.

Other Species of Hogs.—The hog of Guinea—which must not be confounded, however, with the Guinea-pig—is a remarkable and little-known animal. It was described and figured by Marcgrave; and is called *Sus porcus* by Erxleben, and *Sus guinensis* by Brisson and Klein. Its head is small; its ears long, slender, and much pointed; and its tail is long and naked, and reaches to the ground. The hair of its body is short, red, and shining, and is finer and softer than that of any other known race of hogs; the hair of its neck and croup is somewhat longer; and its back is naked.

The babiroussa, *Sus indicus* or *Sus babirussa*, inhabits some of the islands of the Indian archipelago. Its tusks are very long, slender, and curved backward; its ears are short; its feet are comparatively long; and its colour is brownish-grey. The tusks of the female, however, do not project; and her colour is tawnily brownish. The male of this species is represented in *Fig.* 1, *Plate XXXVII.*

The masked African hog, *Sus larvatus* or *Sus Africanus*, inhabits Madagascar and some parts of Southern Africa. Its tusks are like those of the common hog; but a large tubercle, nearly similar in form to the mamma of a woman, and supported by a bony prominence, occurs on each side of the snout, near the tusks, and gives the animal a very singular appearance.

The peccaries are treated by Linnæus as a species of true hog, under the name of *Sus tajassu;* but they figure more appropriately in the systems of Cuvier and of other modern naturalists as two species of a quite distinct, though very nearly allied, genus. Their grinders and incisors are very similar to those of the true hogs; but their canines do not project from their mouth,—they have no external toe to their hind feet,—the metatarsal and metacarpal bones of their two great toes are soldered together into a sort of cannon bone,—they have no tail,—and they excrete a fetid humour from a glandular opening upon the loins. Both species are natives of South America. The white-lipped peccari, *Dicotyles labiatus*, represented in *Fig.* 3, *Plate XXXVII.*, is of a brownish-black colour, with the throat and the lower lip white; and the collared peccari, *Dicotyles torquatus*, represented in *Fig.* 4, has a band of white on the shoulder and the lower part of the neck.

The Comparative Value of the Different Breeds of the Common Domestic Hog.—A coarse coat and pendulous ears are regarded by most experienced judges of hogs as indications of thick skin and large size, and a fine coat and erect ears as indications of small or moderate size and of tendency to rapid growth and fattening. Good or essential points — viewed in the abstract, or regarded as a standard for the testing of any particular breed or specimen — are fineness of bone, thinness and fineness of skin, fulness of head and cheek, thickness and moderate shortness of neck, voluminousness and compactness of body, depth and expansion of sides, breadth of breast and loin, fulness of quarters, moderate shortness of legs, hardiness of constitution, and moderate or rapid tendency to fatten at an early age.

But several of the different breeds of swine are essentially equal to one another in value,—some for one set of circumstances and purposes, and some for another; and while a few breeds are bad in any circumstances, even the best breeds are not good in all. Hogs, like other kinds of farm-stock, ought to be selected with direct reference to their special fitness for the climate in which they are to be kept, for the peculiar management which they are to experience, for the particular kinds of food which they are to receive, and for the precise purposes to which they are ultimately destined. One breed may be best for the bleak exposure of a mountain-farm, and another for the warm and sunny shelter of a farm on a wooded plain; one for the drought and heat of the south-eastern parts of England, and another for the wet and cold of the western parts of Ireland or Scotland; one for roaming at will through field, or moor, or forest, and another for constant confinement in the sty; one for the harsh and stinted food supplied by the moorland cottager, and another for the rich and abundant food supplied by the professional hog-feeder, the general farmer, or the distiller; one to supply pork and bacon for family use, another to supply pork for the public market, and another to supply material for the commercial curer of hams and bacon.

For family use, any hog containing a large or main aggregate of the characteristics of the Chinese breed, is suitable when killed at 6 or 8 months of age, or when possessing a weight of from 4 to 8 stones; but when it is highly fed, and kept to a more advanced age, and fattened up to quite or nearly its maximum of bulk, it loses much of its delicacy, and becomes disagreeably coarse. Yet, for family use, some persons think a Berkshire or a Suffolk hog, killed at an early period, the best; and allege that all the subvarieties and main-crosses of the Chinese, no matter how fed or when killed, are always too fat and very greasy, and never possess the gout and delicacy and good proportionedness between fat and lean of the young Berkshire or the young Suffolk. "For bacon, when the curing of it is considered a staple article," says Mr. James Bell in the Highland Society's Transactions, "the larger breeds are always preferred, being found most profitable for the farmer, and readily taking the market; such as may weigh when killed, the four quarters, from 18 to 22 imperial stones. It is true they have not such a propensity to fatten when young, as most of the smaller varieties; but this is not necessary, as they cannot make good bacon or hams till they are from 15 to 18 months old at least; and they are usually kept till that age, and are then very easily fattened sufficiently for the purpose. For the purpose of curing for pork, as an article of trade, the middle-sized, such as the Northumberland. Berkshire, Suffolk, and Oxford breeds, are to be preferred. They have sufficient tendency to fatten, particularly the Berkshire and Oxford breeds, and their flesh is more delicate, partly, perhaps, from being killed at an earlier age."

Economical Uses of the Hog.—The bristles of the hog are very serviceable to the shoemaker, and are used for making many kinds of brushes. The skin, when young, fresh, and tender, is often eaten along with the flesh; and when old and thick, is tanned into leather for covering pocket-books, for making saddle-seats, and for other purposes. The bladder is prepared, and put to various economical uses, in the same manner as the bladder of the ox. The lard, or purest portion of the fat, particularly that about the loins, is extensively used in cookery, in pastry-baking, in the preparation of pharmaceutical ointments, and in the manufacture of pomatums and other perfumed unguents. The intestines are cut up, cleaned, and melted into a kind of coarse lard for greasing wheels and for other coarse purposes. The head and collar of old boars are made into brawn, and various other parts of the body into several kinds of preserved savoury meats, for gratifying the palate of epicures. The pork or flesh of the carcase is a pleasant, substantial, and nutritious food for all classes of the community; and that of young, well-fed pigs of the choicest breeds, is a delicate aliment for the most aristocratic and fastidious; and though pork cannot be constantly used for a considerable length of time without diseasing the mucous membrane and producing morbid affections of the skin, yet it forms, at all seasons, an agreeable and wholesome alterative to other kinds of animal food. Pork is more susceptible than any other flesh of the antiseptic action of salt, and also readily absorbs an accompanying and powerful antiseptic influence from the proximate principle of smoke; so that it is in extensive request for making bacon and hams, and becomes, in the form of these, a valuable, bulky, long-preserved, and highly-relished article in the stores of both the household and the naval larder.

The hog is valuable to the cottier, the distiller, the general farmer, and all other parties who have much waste nourishment, chiefly on account of its consuming many kinds of coarse food which all other domestic animals refuse, and which, but for it, would require to be thrown to the dunghill. It gathers up and greedily devours many substances which would otherwise be trodden under foot, or at least turned to very little productive account; and it gobbles up, as a perfect feast, the dirtiest refuse of the scullery, the barn, and even in some degree the garden and the field. It eats up and converts into good flesh a great proportion of the light chaffy refuse of the threshing-machine, and other dusty and vegetable sprinklings of the farm-yard, which no other animal could profitably use as food; it elaborates a considerably greater weight and market-value of flesh from the waste of millers, dairymen, brewers, and distillers, than could be elaborated from it by cattle; it turns to profitable account in material for market pork or bacon any excess of roots or coarse herbage which accrues from the preponderance, on any farm, or in any district, of the cultivation of fallow-crops over the cultivation of cereal crops; and it brings out a mass of most cheaply obtained produce to its owner from any wastes or forests where, without risk of transgression upon arable lands, it can find for itself a sufficient aliment in wild-roots, wild-berries, and acorns. See the articles BRISTLES, BRAWN, BACON, and HOG'S LARD. But swine can never be profitable when fed wholly or even chiefly with food which could be consumed by other domestic animals,—and still less when allowed to seek food for themselves upon cultivated land. "A swine stock at present," remarks Mr. Henderson, "are more worth attention than they were in those early ages when the custom prevailed of herding them; yet they are shamefully neglected, and allowed to scramble about for subsistence, picking a precarious and scanty supply from arable fields, under crop perhaps, or other sources, and in such a manner as to render their keep little profitable to their owner, and often a scourge to his neighbours."

The Breeding and Rearing of Swine—The boar and the sow ought to be selected with special reference either to the purity of breed or to some special and well-designed purpose of crossing. See the articles Breeding and Crossing. The boar ought to be not less than twelve months old, and the sow not less than ten months; and both may be used for breeding during from three to five years, and then fed off for the shambles. Young sows differ widely from one another in prolificity and in attention to their pigs; and any which prove on trial to be comparatively unprolific or to be careless nurses, ought not to be retained as breeders. Many breeding sows of more than four years of age, and almost all of more than five or six, become more or less careless about their brood, and are therefore not fit to be continued as breeders; and they, at the same time, begin to suffer considerable deterioration in the qualities of their flesh, so that they must be fattened and killed to prevent loss in their own carcase.

Sows gestate during about 112 days or 16 weeks; and may, therefore, have two litters in one year, or five litters in two years, or ten litters in four years. The most convenient practice, for the sake of adapting the constitution of the pigs to the seasons of the year, and in consequence insuring to them a maximum of hardiness and health, is to secure two litters in each year, the one in February and the other in August. When farrowing occurs in summer, or later in the spring than February, the pigs are too young to be fed off next season; and when it takes place in winter, or later in the autumn than August, they are liable to be injured or even killed by the severe cold which follows, or may suffer serious detriment before spring from a deficiency of roots and of green food.

A pregnant sow ought neither to be confined to a sty nor allowed to travel at will; but may be permitted the full range of a yard, or of any similarly limited enclosure where she can do no damage; and, a considerable time before the calculated period of her farrowing, she ought to be separated from the herd, and kept constantly and cleanly littered with a small quantity of short dry straw. A few hours before her farrowing, she may be observed to carry straw in her mouth to make a bed with; and she must then be allowed only such a berth as is requisite for her comfort, and denied all such rough or long straw as might afterwards, by any accident, cover any of her brood. She ought, when nursing, to be well fed; for if she then lose condition, her pigs will suffer, and she herself will occasion double cost to regain her strength and flesh; and if her litter be numerous, they ought to be fed twice or thrice a-day with a slightly tepid mixture of cow's milk, water, and wheat-bran; and during an hour or two hours at the time of each feed, they may be kept separate from the dam.

Pigs which are not intended to become breeders may be respectively castrated and spayed when about a month old; and all may be weaned, according to circumstances, either when six or when ten weeks old. "The sow and pigs," says Henderson, "should lie dry and warm, and have plenty of 'drinks' given them, mixed with a little meal or wheat-bran, warmed moderately. If the sow and pigs are well fed, the pigs will be ready for sale when six weeks old. If they are not well fed, they must suck eight weeks, which will be found a disadvantage to the breeder, and will cause the loss of two weeks' extra food to both the dam and her family. Every breeder and feeder will find his own advantage in never allowing any of this tribe go to bed with a hungry belly. When the pigs are taken from the sow and weaned, whether with the breeder or purchaser, they must be regularly fed three times a-day, with a little wheat bran, barley dust, or meal of some description or other, mixed with water warmed a little, though not warmer than their mother's milk. In a few weeks after they are taken from their dams and fed thus, they will not be found so delicate, but will occasionally amuse themselves with a few raw potatoes, turnips, or any kind of grain."

The food of growing swine widely varies according to situation, to season, to mode of management, and especially to the circumstances of tho owner. The pig of the moorland cottages must seek a large portion of its food among the wild and woody produce of heaths and waste grounds; the pig of the hind or snug farm cottier must depend mainly on the scanty refuse of his kitchen, his one-cow dairy, and his small cabbage-garden; the pig of the Irish small farmer must depend partly on the weedy produce of road-sides, and principally on the surplus-produce of fallow-cropping over cereal-cropping; the pig of the forester, or of any party possessing similar privileges, may riot at will upon acorns, beech-mast, and other seeds and produce of the woods; the pig of the villa-piggery or of the landowner's home-farm may be pampered with an absolute profusion of the richest and most varied offals; the pig of the miller or the brewer must be fed with the peculiar refuse of the flour-mill or the brewery; and the pig of the farmer may be fed in any one or two or more of an hundred ways, according to the particular character of the farm, the special economy practised on it, the succession of the seasons, and the judgment or caprice of the owner. Yet all the methods of feeding practised on farms and by professional hog-feeders—or, in other words, in rearing the vast majority of pigs for the market, whether for pork or for bacon—may be classified into two,—the method of letting them more or less seek food for themselves, and the method of supplying them entirely with food in the piggery or pig-yard; and probably the best authorities which can be quoted on these two methods, are Henderson in reference to the former and Boussingault in reference to the latter.

"The young stock, after the harvest is concluded," says Henderson, "may be allowed to range at large among the fields to pick up any left corn, beans, or pease, &c., and their mothers may be allowed to go along with them in case they are not put up to feed. The keeper must always be along with them to prevent them doing any damage, or straying too far abroad. They may likewise be allowed to go upon the new sown wheat, provided the ground is dry, as their trampling is of some service to that grain. But it must then be observed to have nose-jewels well secured in their snouts, to deter them from acting the ploughman. Before going out in the morning, always acknowledge them with something for breakfast, and when they draw near their lodgings in the evening, have a similar allowance in their manger. A few Swedish turnips, or even common ones, cut into small pieces, may be given them; or potatoes occasionally, as the feeder may see requisite. In feeding, great care must be taken not to give them such a quantity of food as may overload their stomachs, which may be in danger of causing them to leave off feeding. If at any time they seem rather to loath their food, and leave a part of it, the only way to remove that, is to lessen the quantity, and now and then change their diet, giving them a few oats, barley, beans, or pease, two or three times a-week, and to be particular in giving them no more than their appetite can devour. During the summer, the feeder ought assiduously to purchase wheat bran, barley dust, &c., and keep as much of the refuse of grain as possible. Let them have a little of such articles twice a-day, mixed with water. With those, together with what clover and grass they get in the fields, pigs can make a very good shift until the time of close-feeding."

"The hog, as all the world knows," says Boussingault, "is an animal the least dainty in his food; he is omnivorous, nothing comes amiss to him; but his food is by no means matter of indifference when the quality of the flesh comes to be considered. Thaer seems to think that maize is of all articles that which is the best for feeding swine; and I have had occasion to verify the accuracy of his conclusion in South America, where, I may add, it is found that the oily fruit of the palm-tree contributes powerfully to the fattening. Almost all the varieties of roots and grain produced upon the farm are suitable for the maintenance of the hog; but in Alsace, and I believe generally, the staple is the steamed potato, with which are associated various articles in smaller quantity, such as pease, and barley and rye meal, &c. The farrow sow ought to have food by so much the more abundant and nutritious as she is required to suckle a larger number of pigs. Our allowance at Bechelbronn to the hog with five young ones during the six weeks of suckling is as follows: 24·75 lb. of steamed potatoes equal to 7·8 lb. of hay, 2·45 lb. of rye-meal equal to 4·0 lb. of hay, 13·2 lb. of skim milk equal to 6·2 lb. of hay. After the fifth week, when the animal is no longer giving suck, the ration consists of 12·1 lb. of steamed potatoes equal to 7·3 lb. of hay, 1·0 lb. of rye-meal equal to 1·6 lb. of hay, 6·5 lb. of sour skim milk equal to 3·3 lb. of hay. This allowance is gradually reduced to the end of the second month after the farrowing, when the animal is upon the maintenance ration of the farm consisting of 16·5 lb. of steamed potatoes equal to 5·2 lb. of hay. The potatoes are mixed with dish washings, which certainly contribute to improve their nutritive power, although I am altogether at a loss to estimate the value of the article. The young pigs begin to taste the food given to the mother at about the age of a fortnight, but they never take to this kind of food freely until they are four or five weeks old, and are weaned; up to this time they have an allowance of skim milk and whey. To five pigs at the time of weaning we allowed per day 22·0 lb. of steamed potatoes equal to 7·3 lb. of hay, 1·0 lb. of rye-meal equal to 1·6 lb. of hay, 6·6 lb. of skim milk equal to 2·8 lb. of hay. This allowance was modified by degrees; the quantities of milk and rye-meal were gradually abridged, and the proportion of potatoes increased, so that about the third month the allowance per head was from 11 to 13 lb. of potatoes mixed with greasy water. This is the regimen, equivalent to about 5 lb. of hay, upon which our store pigs are maintained until they are put up to fatten. During the three months which follow the weaning, therefore, we may reckon that each animal has consumed 3·8 lb. of meadow hay per day, and that from the third month the consumption may be represented by 5·2 lb. of the same article. We have attempted in vain to replace the potato by rape or media oil cake; the pigs refused it obstinately, but they showed no objection to poppy seed, walnut and linseed cake; during the season they will also eat clover, and are partly maintained upon this plant. In summer they are entirely put upon green meat, animals from 5 to 6 months consuming about 19 lb. of clover a-day, a quantity which represents very nearly 5 lb. of clover hay."

Three elements of great importance in the rearing of swine, are to keep them comfortably warm, to afford them a constant supply of fresh air, and to keep them perfectly free from every kind of nastiness and filth. The necessity of comfortable warmth at all seasons, and the positive saving it effects in both food and strength, are pointed out in the article FEEDING OF ANIMALS. Pigs which have little or no protection from the cold winds, cold rains, sleet, and snow, and which try to keep one another warm by cowering together in heaps, and which, in spite of every device they practise, often shiver with cold amid the severities of spring and winter, cannot possibly thrive upon even the best and most abundant food which man can supply; and if, on the other hand, they enjoy no shade from the scorching and blistering play of sunshine in summer, they both will become somewhat unsightly in appearance, and may be occasionally made sick, and generally retarded in growth. The necessity of a constant supply of fresh air is shown in the article AERATION. A close, ill-ventilated sty has an absolutely pestilential atmosphere, and makes pigs look delicate and sickly, and undermines their very constitution, and prevents them from ever attaining proper size and weight; while a sty with an open-barred door, and a constant current of fresh air, maintains them in vigour, gives them the full advantage of their food, and affords full and facile scope for their rapid growth and ample maturation. Cleanliness, not only of the litter and of the floor of the sty, but of the feet and all the skin of the animals themselves, is essential to the energetic performance of the organic functions, and even to the prevention of comparative dwarfishness and some measure of disease. The propensity of swine to roll themselves in mud in summer only proves that they require protection from the scorching heat of the sunshine, and from the attacks of flies, and affords not the remotest indication that any daubing of the pores with dirt can possibly be beneficial. A washed sow in the hot season of our temperate climate, and in almost every season in such a climate as that of Palestine, "returns to her wallowing in the mire," simply because she feels scorched and blistered and sickened under the ardent sunshine: and hence when she receives from man the aid which is due to her as a domesticated animal, she demands, not dirt all the year through or on any day at all, but shade in summer, shelter in winter, and a clean dry bed in every season. Of six pigs of nearly equal weight, kept for seven weeks on the same food and litter, three were maintained as clean as possible with a brush and a curry-comb, and were found, at the end of the seven weeks, to have consumed five bushels less of pease than the other three, and yet to have acquired on the average two stones and four pounds of greater weight of carcase.

The Fattening of Swine.—Swine are sent to the shambles at various ages, under various names, and for various precise purposes. Those fattened and sold at the age of a few weeks are called pigs, and usually roasted whole; those fattened and sold at the age of five or six months are called porkers, and commonly cut up and used as either fresh or pickled pork; and those fattened and sold at full size are called hogs, and usually converted into ham and bacon.

The fattening of sucking pigs requires only that the dam be kept well-lodged and abundantly nourished; the fattening of weaned pigs requires the constant use of whey or skim milk or butter-milk, with the frequent intermixture or addition of beans, pease, or barley-meal; and the fattening of prime porkers requires similar treatment to that of weaned pigs, or the use of a mixture of pease-meal and barley-meal, moistened with as much milk as will make it drinkable. Boussingault ascertained, in one well-conducted experiment, that a properly suckled litter of five pigs increased in weight, during 35 days of suckling, from about 13¾ lb. to 177 lb.; and, in another, that eight weaned pigs, fed on food equal to 5·2 lb. of hay each a-day, and on a small additional allowance of whey and scraps, increased in weight, during eleven months, from 114 lb. to 1,206 lb. Each of the sucking pigs, in the first experiment, therefore, increased, on the average, from a weight of 2·75 lb. to a weight of 18 lb., or at the rate of 0·506 per day; and each of the weaned pigs, in the second experiment, increased, on the average, from a weight of 14·3 lb. to a weight of 150 lb., or at the rate of 0·4 per day.

Some varieties of hog may be fattened so early as at ten or twelve months of age; and others do well to be fattened at about 15 months; but most fatten best at about 18 or 20 months; and brood swine, as was formerly hinted, should be fattened at about 5 years. A period of twelve weeks is generally requisite for bringing even the kindliest fattening hogs into prime condition; a period of 16 weeks is requisite for rendering the majority of hogs really fat; and a period of 20 weeks is requisite to bring not a few, or even the greater number, into prime condition. All properly fattened hogs have a layer of fat beneath the skin of more than an inch in thickness; and some attain such enormous size, that their skin is lifted, chiefly by deposits of fat, 15 inches above the bone.

Hogs, while fattening, ought not to be allowed to run about; for they cannot possibly effect such a saving of food from what they may pick up in the fields as will compensate for their loss of flesh by continual exercise. Yet some exceptions must be made in the case of some peculiarly situated hogs, and particularly in the case of such as largely feed and fatten upon acorns. The food used for fattening must be of the richest quality which will comport with due regard to economy, and with the peculiar circumstances of different piggeries, farms, and districts; and it ought to be given frequently, in small quantities at a time, in a perfectly clean condition, and in thoroughly clean and sweet troughs or mangers,—and should be occasionally varied and changed, and seasoned with salt. But the general principles of feeding in order to produce fat considerably differ from those of feeding in order to produce growth and strength; and they are stated in our article on the FATTENING OF ANIMALS.

Grains, oil-cake, and milk are commonly used for fattening in breweries, distilleries, oileries, and dairies; and potatoes and turnips, mixed with either bean-meal, pease-meal, oat-meal or barley-meal, and either raw or steamed, on the great majority of arable farms. Mr. Boswell proved by experiment that, during an equal space of time, five pigs fed on steamed food increased in live weight 4 cwt. 2 qrs. 7 lb., at an expense of £6 19s. 4d., and five pigs fed on raw food increased in live weight only 2 cwt. 2 qrs. 21 lbs., at an expense of £5 8s. 6d. M. Bengtrapp fed and fattened five pairs of pigs upon respectively five different kinds of food, and obtained results which showed that one decalitre of pease, equal to 15 pints, produces nearly 6 lb. of pork, one decalitre of buck-wheat about 4 lb. of pork, one decalitre of boiled potatoes nearly 3 lb. of pork, one decalitre of boiled carrots about 2¼ lbs. of pork, and one decalitre of balls of wheat only about 1⅕ lb. of pork. The facts which elicited these results were as follows:—one pair of pigs consumed 55 decalitres of pease, and increased in weight 22 st. 7 lb.; another pair consumed 96 decalitres of buck-wheat, and increased in weight 26 st. 10 lb.; another pair consumed 98 decalitres of boiled potatoes, and increased in weight 20 st. 4 lb.; another pair consumed 175 decalitres of boiled carrots, and increased in weight 28 st. 2 lb.; and another pair consumed 283 decalitres of balls of wheat, and increased in weight 24 st. 3 lb. Yet these facts afford merely hints, and not guidance; for we do not know whether the five pairs of pigs were of the same breed, or had the same constitutional tendency to fatten, or were nearly of the same age and weight, or received as much food as they could eat, or were fed in the same circumstances of shelter and management; and while the potatoes and the carrots were given in the advantageous state of being boiled, and the pease and the buck-wheat were probably given in either a triturated state or some other state of preparation, the wheat, in order to correspond, ought to have been given either in flour, or still better in small dry balls of dough, or best of all in broken and pulverized flour-bread.

M. Boussingault reports as follows upon seven hogs, each 15 months old and in good condition, which he put up to fatten on the 6th of September 1841:—They had hitherto had the usual hog's food,—sour milk and boiled potatoes after weaning,—by and bye, from 11 to 15 lb. of potatoes, whey and dish-washings. The seven weighed 1,691·8 lb.,—or each 241·67 lb.; and supposing each to have weighed 13·7 lb. at the time of weaning, each had increased at the rate of rather better than half a pound, or 0·528 lb., a-day. They were fattened till the 20th of December, and they then weighed 2,101 lb.; so that, during the 104 days of fattening, they increased in weight 409·2 lb., being an average for each of 58·457 lb., or at the rate for each of 0·572 lb. per day. They consumed in the course of the 104 days, 772 lb. of barley equal to 1,144 lb. of hay, 1,042·8 lb. of pease equal to 4,171 lb. of hay, and 9,504 lb. of potatoes equal to 8,296 lb. of hay, besides an undetermined quantity of whey and greasy water; so that 4·91 lb. of live weight of flesh were produced by every equivalent in provender for 100 lbs. of hay. Their dead weight, when slaughtered, and after being freed from their offal and deprived of their heads and feet, amounted to 1,702·6 lb. "The observations which I have made on the fattening of hogs," says M. Boussingault, after detailing other experiments, "may be summed up in the following terms:—

Provender expressed in lbs. of hay.	Increase per day.	Live weight obtained from every 100 lbs. of provender.	Age of the animal at the beginning of the experiment.	Duration of the experiment.	
lbs.	lbs.	lbs.	Months.	Months	Days
5·1	0·440	8·58	1	11	,,
13·5	0·836	13·21	9	,,	21
15·7	1·958	12·52	9½	,,	20
,,	1·254	,,	12	,,	,,
11·6	0·572	4·91	15	,,	104
15·4	0·660	4·21	14	,,	58

The allowance to the hogs, in the preceding observations, was always abundant. To determine the quantity of potatoes consumed each day by a hog in full growth, and whose weight was known, I had him weighed at intervals, as well as the potato ration, placed before him at will, which he ate daily; and I found that, when he weighed 138 lb., he daily ate 11 lb. of potatoes, equivalent to 3·4 lb. of hay,—when he weighed 145 lb., he daily ate 13·2 lb. of potatoes, equivalent to 4·2 lb. of hay,—when he weighed 160½ lb. he daily ate 15·4 lb. of potatoes, equivalent to 4·8 lb. of hay,—and when he weighed 184·8 lb., he daily ate 17·6 lb. of potatoes, equivalent to 5½ lb. of hay."

The Diseases of Swine.—Indigestion sometimes occurs among swine who are not supplied with food at regular intervals, and occasionally receive large or unlimited quantities of it, and in consequence pass suddenly from starvation to a surfeit; and this evil greatly retards their growth or fattening, or seriously damages their health, or even undermines their constitution; and it must be rectified by supplying them with proper allowances of food at stated periods of the day, and never in such quantity at a time as to provoke them to gluttony.

Costiveness, accompanied by disinclination for food, sometimes results from great and sudden changes of weather, and from other causes; and this may be corrected by giving them any green food or succulent vegetable substance which may happen at the time to be most plentiful,—such as a few cabbage-leaves, some lettuces, some potato-tops, or a mixture of potatoes and mangel-wurzel. The opposite evil of diarrhœa, also, is sometimes induced; and this may be corrected by giving them a fresh sod dug from the road-side, or by permitting them access to a yard where they can readily find some cinders, mould, brick-dust, and chalk-rubbish.

Cutaneous eruptions, occasionally becoming aggravated into pustules and scabs, sometimes break out in the ears, and spread over the whole body; and these may be occasioned either by want of proper ventilation, by want of cleanliness in sty and litter, by paucity of food, or by too stimulating a diet, or by the combined effects of confinement, bad air, and injudicious feeding. A ready and effective cure, in the early stages or milder forms of this malady, is simply to give the animals some cinders or charcoal; and a suitable or even requisite remedy, in bad cases, particularly when the eruptions have become scabby and ulcerated, is to mix small doses of sulphur and saltpetre with the food, and to rub externally with a mixture of oil and tar, or with a composition of suet, tar, and a very little sulphur.

A virulent kind of pustular disease, called swine-pox, is not uncommon; and may be treated in the same manner as bad varieties of ordinary cutaneous eruptions,—or with external application of the tarry and sulphurous unguent, and the inward administration either of small doses of sulphur and madder, or of these doses accompanied with pease-porridge or brewer's grains.

A kind of leprosy sometimes becomes somewhat common in hot and peculiar seasons; and this is best combated by keeping the swine constantly in the shade, withholding from them every sort of animal food or heating diet, and keeping them clean, cool, and in constant and ample ventilation.

Measles are not uncommon, but seldom prove fatal. The earlier symptoms are languor and decline of appetite; and the later ones are small pustules on the throat, together with red and purple eruptions. The best remedies are a little sulphur, small quantities of sesquisulphuret of antimony, and moderately aperient doses of Epsom salts.

Inflammation of the lungs or of some other important internal organ, is by far the worst of the diseases to which swine are subject; and it especially attacks such as constantly feed on a heating diet, and occasionally makes sad and sudden havoc among those of a distillery or a brewery. Some of the chief symptoms are total loss of appetite, a severe cough, and laboured breathing. The suitable remedies are prompt and copious bleeding, moderate and cautious doses of Epsom salts or castor oil, and a judicious administration of such febrifuges and sedatives as compound powder of antimony and some form of digitalis.—*Cuvier's Animal Kingdom.—Fennel's Natural History of British Quadrupeds.—Henderson on Swine.—Culley on Live Stock.—Hibbert's Shetland Islands.—Walker's Hebrides.—Reports to the Board of Agriculture.—Marshall's County Reports.—Hunter's Georgical Essays.—Gilpin's Forest Scenery.—Boussingault's Rural Economy.—Mill.—Low.—Young.—Sproule.—Loudon.—Magazine of Domestic Economy.—The Farmer's Magazine.—Transactions of the Highland Society.—Q. Journal of Agriculture.*

HOGBERRY. See BIRD-CHERRY.

HOGG, or HOGGREL. A sheep of a year old.

HOG-NUT. See CARYA.

HOG-PLUM,—botanically *Spondias*. A genus of tropical, evergreen fruit-trees, of the terebinth family. The yellow species, *Spondias lutea*, or *Spondias myrobalanus*, and the purple species, *Spondias purpurea*, both naturally about 35 feet high, have been introduced to British botanical collections from the West Indies; and the mango-bearing species, *Spondias mangifera*, and the sweet Otaheite apple, *Spondias dulcis*, both naturally between 50 and 60 feet high, from respectively the East Indies and the Society Islands. The fruit of the yellow species, when ripe, has a pale yellow colour, and a pleasant flavour, but is a little too acidulous; and it is used, in some places, in cookery. The fruit of the mango-bearing species has some resemblance to a mango, but is harsh, and little deserving of notice. The root, the bark, and the wood of the mango-bearing species, are used in India as medicines,—the first as an emmenagogue, the second for dysentery, and the third for gonorrhœa.

HOG'S LARD. The clarified fat of the flank of hogs. The fat is freed from the membranes and organic vessels, by being cut into small pieces, well washed in water, and melted with a gentle heat and kept on a slow fire till the whole of the water has evaporated. If exposed to the air, it soon undergoes partial decomposition, imbibes oxygen from the atmosphere, forms sebacic acid, and becomes yellowish, rancid, and ill-smelled; and it is therefore run into bladders immediately after being clarified, and is kept in them till required for use. Sound lard is white, tasteless, odourless, and so soft as to be almost semifluid; it begins to melt at 80°, and is a transparent and nearly colourless oil at 99°; it consists of 62 per cent. of elain and 38 of stearin; it is dissolved and decomposed by strong acids, and saponified by alkalies; it is insoluble in either water, alcohol, or ether; and, when pressed between the folds of blotting-paper, it is resolved into its two proximate constituents, the elain being absorbed by the paper, and the stearin remaining between the folds.

Hog's lard is commonly used by the cook and the pastry-baker; but though better suited than butter for frying fish and for similar purposes, it is very ill-suited for pastry, and ought not to have a place in any bread. Its grand use is to serve as the basis of almost all ointments both in human pharmacy and in veterinary practice; and it is admirably adapted to this use, not only by its peculiar consistency, but by its emolliency, and its perfect freedom from every stimulating property.

HOGWEED. The indigenous cow-parsnip,—*Heracleum Sphondylium;* also the plants of the genus Boerhaavia. See the articles COW-PARSNIP and BOERHAAVIA.

HOITZIA. A genus of tender, ornamental plants, of the polemonium family. Three species, small evergreen shrubs of from 12 to 40 inches in height, with respectively scarlet, pinkish, and pale blue flowers, were introduced to Britain about 23 years ago from Mexico; and 5 or 6 other species are known.

HOLCUS,—popularly *Soft Grass.* A genus of grasses, of the oat tribe. It comprises two indigenous species, and three or four foreign but unintroduced species; and it formerly comprised other species which are now assigned to the genera arrhenatherum, chrysopogon, sorghum, and hierochloe. In the Linnæan system, it lies very far apart from the triandrous class or main body of the grasses, and belongs to the small group of monœcious polygams. In both the Linnæan and the Jussieuan systems, it stands close by the side of the genus arrhenatherum; and it is distinguished from that genus in having the upper floret of the spikelet with stamens only and awned, and in having the lower floret perfect and awnless.

The woolly soft-grass, meadow soft-grass, or Yorkshire fog, *Holcus lanatus,* grows naturally on all sorts of meadows and pastures throughout Britain; but occurs principally on light inferior soils, and especially on such as are dampish and contain some proportion of peat. Its root is fibrous and perennial; its culms are numerous, erect, from 18 to 36 inches high, and smooth above but hairy below; its leaves are downy on both surfaces; its panicle is erect, thrice-compound, spreading, and rather crowded, and has a soft and woolly appearance, and assumes a great variety of shades of colour, from a white to a beautiful red, but generally on a whitish-green ground; its spikelets are two-flowered, and bloom in July and August; and its awn is recurved, and much shorter than the floret. This grass yields a great weight and a still greater bulk of herbage, or rather of foggage; but—probably in consequence of the spongy softness of its texture, and of its deficiency in saline, subacid, or other sapid properties—it is not relished by cattle, either in its growing state, or when made into hay. It may be seen in many a pasture, with perfect untouched leaves, when all other grasses around it are cropped to the ground; and, in general, it is eaten by cattle only when they are hungry and cannot get anything better. A remedy for its insipidity, in the form of hay, may be found in sprinkling it over with a little salt when stacked; but no remedy seems available for it in the fields, except to treat it as a weed, and endeavour to exterminate it. But, like many other bad things and bad persons in the world, it clings to its place with a tenacity proportionate to its worthlessness; and cannot be driven out by less severe means than either a long course of constant stocking and of never allowing it to seed, or ploughing up the pasture which it infests, subjecting it to a five years' course of aration, and then sowing it down with a mixture of the most profitable grasses. In the Woburn experiments, the woolly soft-grass, when grown upon clayey loam, yielded per acre, when in flower, 19,057 lbs. of green produce, 6,193 lbs. of dry produce, and 1,191 lbs. of nutritive matter.

The creeping or bearded soft-grass, *Holcus mollis,* grows naturally on almost all sorts of soils in Britain, but chiefly in light arable lands, and on barren sandy grounds. Its roots are perennial, and very powerfully creeping; they sometimes attain, in a few months, the enormous length of three or four feet; and they retain such pertinacious possession of the soil as to resist all labours, except the most strenuous and persevering, for their extirpation. This grass is more slender and less downy than the woolly soft-grass; its culms are fewer, and only about two-thirds of the height; its leaves are broader, softer, and less tufted, or grow more separately from one another; its panicle is looser and smoother, and has, in every instance, a whitish-green colour; and its awns are longer and more conspicuous, and, when dry, bend at a right angle, and extend beyond the calyx. This grass shares with *Agropyrum repens* the popular and ignominious name of couch-grass or twitch-grass; and it is almost as emphatically the real couch of light sandy lands as the other is of richer soils. In all circumstances, it is more or less a sheer weed, and a very vivacious one; and wherever it exists even in grass lands, it ought to be exterminated in order to make room for better grasses. Its spring herbage is small; and its aftermath growth is perfectly trivial. Its roots, indeed, abound in nutritious matter, and have a flavour like that of new-made meal, and are very much relished by pigs, and might, on some almost barren arenaceous lands, be an object worth a little attention; but the roots of *Agropyrum repens* have even more of this useful character; and both plants must, nevertheless, be regarded as excessive pests of cultivated land. The checking and subduing of the creeping soft-grass must be attempted by the most careful and searching performance of the cleaning department of fallowing; and the extermination of it can, in general, be effected only by combining this work with such periodical intermixations of clay as shall convert the sandy soil into a loam. See the articles COUCH-GRASS and FALLOW. In the Woburn experiments, the creeping soft-grass, when grown on sandy loam, yielded per acre, when in flower, 34.031 lbs. of green produce, 13,612 lbs. of dry produce, and 2,392 lbs. of nutritive matter.

HOLEING. A particular method of planting trees and shrubs. A hole or small pit is dug in autumn; the turf and surface-strata are placed aside to be decomposed and mellowed by the action of the air and weather; and the tree or shrub is planted in the following spring. A hole two feet wide and 18 inches deep is required for a plant of two feet in height; and holes proportionally larger are required for plants of larger growth; yet, in every instance, the circumference of the hole ought to be greater than that of the periphery of the roots. Holeing is suitable only for thoroughly porous ground, and totally unsuitable for clay, stiff loam, binding gravel, or any other kind of ground which retains water. The great recommendation of the method is the decomposing and pulverizing action of the atmosphere, preparatory to the depositing of the plant.

HOLLOW. A depression in land, or a horizontal cavity,—whether but an inch or two in width, such as is made by the poachings or footmarks of sheep or cattle, or many yards or even miles in extent, such as to be identical with a dingle, a vale, a glen, a valley, or any variety whatever of hill-locked land.

HOLLOWNESS. Cavitousness in the stem of an old tree, occasioned by the decomposition and disappearance of part of the duramen. The decayed portion of the stem may be probed to the bottom; the water, if any, let out with an auger; the cavity dried with a cloth, and filled with dry sand; and the opening plugged with wood and oakum, and made fully air-tight with a coat of paint.

HOLLOW ROOT. See MOSCHATEL.

HOLLY,—botanically *Ilex*. A genus of ornamental, evergreen, ligneous plants, of the staff-tree family. One species grows wild in Britain; nearly a score of species have been introduced from Africa, America, and China; and about twenty more are known. Two of the foreign species are noticed in the articles DAHOON and CASSINE.

The indigenous, or common, or prickly-leaved holly, *Ilex aquifolium*, is a handsome, conical, evergreen tree. Its English name is probably a corruption of the word *holy*, the boughs being used to adorn houses and even churches at Christmas. It is the *Houx* of France, the *Stechpalme* and *Hülsenbaum* of Germany, and the *Agrifoglio* of Italy. It reaches a height of 30 or 40 feet, with a trunk from 18 inches to 2 feet in diameter. As a hedge-plant, or as an ornamental tree or shrub, it is not surpassed by any other evergreen. Its variegations are chiefly confined to the modifications of white and yellow in the leaves; but there are some kinds in which the deviation results from the size, form, and prickly state of the leaves; others consist of differences in the colour of the fruit, which is red, yellow, black, or white. This plant is indigenous in Europe, and is said to be found in China and Japan. In France it is abundant, especially in Brittany; and in the middle and southern states of Germany, it attains the height of 20 feet; but it nowhere reaches a larger size than in England, where it appears in the reremains of all aboriginal forests. In Ireland it is not very common; but in Scotland it is found in most natural woods. The holly-hedges at Tyningham, planted in 1712, are from 10 to 25 feet in height, and from 9 to 13 feet wide at the base.

The holly, according to Loudon, attains its largest size in a rich, sandy loam; but it will grow, and even thrive, in almost any soil, provided it is not overcharged with moisture. Cook says, it does best on soils somewhat gravelly; Miller, that it prospers on gravel over chalk; and Boutcher, that it refuses not almost any sort of barren ground, hot or cold; in short, it is found on all soils, except in bogs or marshes. The largest hollies at Surrey and Kent, are in loam or chalk; those at Tyningham are on a deep, alluvial sand; and those in Aberdeenshire, on granitic clay. The most favourable situation for the holly, in England, is said to be a thinly scattered wood of oaks, in the intervals of which, it grows up at once sheltered and partially shaded. Yet it will thrive completely beneath the shade and drip of other trees; for which reason it is surpassed, as undergrowth, by no other evergreen shrub or tree, except the box.

The holly may be propagated by seeds, by cuttings, or by budding and grafting. As the seeds, like those of the hawthorn, do not come up the first year, the berries, in England, are commonly buried in the soil, or kept mixed up in a heap of earth for one year. Mr. Loudon recommends mixing the berries as soon as gathered, in a heap of earth, which should be turned over several times in the course of the season, to facilitate the decomposition of the pulp and husks. This will generally be effected by the autumn succeeding that in which they are gathered from the tree; and they may then be taken, and separated from the earth, with which they are mixed, by sifting, and sown in beds of finely prepared soil, and covered to a depth of about a quarter of an inch. Thus prepared, when sown in autumn, they will come up the June following. A covering of half-rotten leaves, or of straw, placed over the seed-beds, will protect the soil from extreme heat and drought, and will greatly facilitate the progress of the germination.

As the holly is liable to suffer from transplanting, it should never be kept in the nursery longer than two years in one place. When the seeds are to be sown immediately after gathering, Boutcher directs that the berries should remain on the trees till December, or, if they could be kept out of the reach of birds, till February or March. As soon as they are gathered, he says, "throw them into a tub with water, and rub them between your hands till the seeds are divested of their thick, glutinous covering; pour off the water, with the light seeds that swim, the mucilage, &c., and spread the sound seeds on a cloth, in a dry, airy place, rubbing them often, and giving them a fresh cloth daily till they are quite dry. If this be done in autumn or winter, mix them with sand, and keep them dry till spring; but, if they have been gathered in spring, let them be sown immediately." When cuttings are made choice of for the propagation of the holly, they are selected in autumn, of the ripened summer shoots. They are planted in a sandy soil, in a shady border, and covered with hand-glasses; and they generally strike root the following spring. It has been found by experience, that cuttings of trees and shrubs generally, which are grown nearest the ground, or on the north side of the tree, and so planted as to be kept moist and shaded, always take root more readily than those which have been taken from the summit, and more exposed to the influence of light and air, the moisture and shade being the predisposing causes of the production of the roots. The operations of budding and grafting may be performed at the usual times and in the usual manner; but it has been observed by Tschoudi, that cleft-grafting does not succeed nearly so well with the holly as whip-grafting. In England, the stocks budded or grafted, are generally of four or five years' growth; and the grafting is performed in March, and the budding in July. No plant requires less care than the holly, when it is once established. This species rarely needs pruning; and the varieties which have been grafted or budded require little more than the removal of shoots from the stock. To prepare them for removal, however, whether of a large or small size, they ought to be taken up and replanted every other year. The seasons most usually adopted for the transplanting of evergreens, are the spring, and in mild weather in winter, although summer and autumn are generally stated to be the proper times for performing that work. The principle which justifies the practice of removing them in winter or spring is, that most plants are more safely removed when they are in a comparatively dormant state, and when the weather is temperate, the air moist and still, rather than dry and in motion. It is well known that the greatest degree of torpidity in plants or trees exists a short time before they begin to germinate or push out shoots; consequently, as evergreens begin to grow only a week or two later than deciduous trees of the same climate, the proper time for transplanting them must be nearly the same. The chief difference to be observed is, the circumstance of evergreen trees being at no time whatever in so completely a dormant state as deciduous ones; and hence, such weather in winter, autumn, or spring, must be chosen for removing them, as will least affect their fibrous roots and leaves by evaporation. When the holly is to be planted as a hedge, if it is desirable that the growth shall be rapid, the soil ought to be trenched to the depth of three or four feet. If the subsoil be poor, it is recommended to dig a trench, in the direction of the intended hedge, three or four feet wide, and as many deep, and to fill up the space with good surface soil taken from the neighbouring ground or elsewhere. The soil in the trench should be raised at least a foot above the adjoining surface, to allow for settling; and along the middle of this ridge, the plants should be set from one foot to eighteen inches apart. According to Miller, holly hedges should never be clipped, because, when the leaves are cut through the middle, they are rendered unsightly; and the shoots should therefore be cut with a knife close to a leaf. This mode, undoubtedly, is more appropriate for hedges in gardens and pleasure-grounds, where it is desirable to preserve an effect more pleasing to the eye; but, as this method leaves a rougher exterior surface, and involves a much greater expense than clipping, it is unsuitable where the object is to prevent birds from building in the hedges, and to maintain effective fences at the least expense. The proper time for clipping appears to be just after the leaves have arrived at maturity; because at that season, in the holly, as in the box, the wound is repaired, in a measure, by the healing over, produced by the remaining sap, still in circulation. When it is desired to cultivate the holly for timber, it should be grown in the same manner as in close plantations, either with or without nurse-trees, according to the situation; and the stems should be deprived of their side branches, when they are less than half an inch in diameter, to a certain height, say one-fourth of the entire height of the tree, in order to have a clean trunk.

The wood of the holly is almost of an ivory whiteness, except near the centre of very old trunks, where it is of a brownish hue. It is very hard and compact, with a fine grain, and susceptible of a high degree of polish, which renders it well-adapted for many purposes in the arts. When dry, it weighs forty-seven and a half pounds to a cubic foot, and is very retentive of its sap, in consequence of which, it is liable to warp, unless it is well dried and seasoned before being used. It readily takes a durable colour of almost any shade, and hence it is much used by cabinet-makers in forming what are technically called "strings and borders," in ornamental works. When properly stained black, its colour and lustre are little inferior to those of ebony. It may be applied to a great number of purposes by joiners, cabinet-makers, turners, engineers, mathematical instrument-makers, and, next to the box and pear-tree, it is the best wood for engraving upon, as it is compact, and stands the tool well. Among its principal uses in England, at present, is, when dyed black, to be substituted for ebony, in the handles of metallic teapots, &c. In France, the young shoots and the branches are given to sheep and deer, during winter; and the stronger straight shoots, deprived of their bark, are made into whip-handles and walking-canes. The bark of the holly contains an abundance of viscid matter; and, when macerated in water, fermented, and then separated from the fibres, it forms bird-lime. Medicinally, the bark of this tree is mucilaginous, emollient, and solvent, and is said to possess strong febrifugal powers. The berries are purgative, and six or eight of them, when swallowed, will cause violent vomiting; though they are considered as poisonous to men, they form the food of some birds, more especially of the thrushes.

As a hedge-plant, in temperate climates, the holly forms, perhaps, the most impenetrable and the most durable of all live fences; and it has this superior advantage over deciduous-leaved trees, that it is seldom attacked by insects, and will well endure the shears. Its chief objection is the very indifferent progress which it makes for the first few years after planting; but, after it becomes established in a suitable soil, or about its third or fourth year, there are but few hedge-plants that will surpass it in their growth. It may be carried to a great height, and, consequently is well-adapted for situations where strength and shelter are required, especially during winter, when most other hedges are deprived of their leaves.

The common holly comprises so many varieties, widely different from one another, and all more or less beautiful, that a shrubbery with nothing else in it could be made very imposing, —and quite eminently so with the aid of a few pines and firs; and it presents so great a choice to the landscape-gardener that it may often be depended on as a main subject for the general outline and for conspicuous situations. The following varieties are enumerated by Loudon:—*heterophyllum*, various-leaved; *angustifolium*, narrow-leaved; *latifolium*, broad-leaved; *altaclerense*, High Clere, with broad thin flat leaves; *marginatum*, thick-margined-leaved, without prickles; *laurifolium*, laurel-leaved, small, without prickles; *ciliatum*, ciliated leaves, small, with hair-like prickles along the margins; *ciliatum minus*, smaller ciliated; *recurvum*, recurved-leaved; *serratifolium*, saw-leaved; *crispum*, curl-leaved; *ferox*, the hedge-hog holly, the surface of the reflexed leaves covered with prickles; *crassifolium*, thick-leaved; *senescens*, spineless, or aged; *albo-marginatum*, white-edged-leaved, of which there are numerous variations; *aureo-marginatum*, gold-edged-leaved, many variations; *albo-pictum*, white-spotted-leaved, of which a considerable part of the centre is white, and the margin green; *aureo-pictum*, gold-spotted-leaved, in the same way as the last, many variations; *ferox argenteum*, silver-blotched hedgehog; *ferox aureum*, gold-blotched hedgehog; *fructu-luteo*, yellow-fruited; *fructu-albo*, white-fruited. Of these the following are markedly distinct in appearance,—angustifolium, marginatum, ciliatum, serratifolium, ferox, crassifolium, fructu-luteo, and instances of the six different kinds of variegation. A pendulous variety, of a strongly marked character, exists in Dalkeith Park; and a fastigiate one in the neighbourhood of Edinburgh.

The American holly, *Ilex opaca*, is widely diffused throughout the U. States, extending from about lat. 42° to the gulf of Mexico, and beyond the Mississippi to the border of the desert plains which skirt the base of the Rocky mountains. In many parts of this district, it is not uncommon, and adds to the beauty of the forest by its red berries, and brilliant evergreen foliage. It sometimes attains a height of forty feet, with a trunk a foot in diameter. The leaves are undulated, coriaceous, dentate, and spiny on the margin; the flowers, as in the rest of the genus, inconspicuous, consisting of a four-toothed calyx, four petals, and as many stamens; and they are succeeded by rounded berries containing four osseous seeds. The European holly is very similar to the American in size, appearance, and the qualities of the wood.

The emetic holly, or South-Sea tea, *I. vomitoria* or *I. religiosa*, is a shrub, inhabiting the Southern states from lat. 37° to the gulf of Mexico, bearing smooth, elliptical and serrated leaves, an infusion of which is taken like tea, by the aborigines, who ascribe to it extraordinary virtues, and are accustomed to assemble every spring, with much ceremony, for the purpose of drinking it. It is tonic and diuretic, and, in large doses, purgative and emetic.

The narrow-leaved holly, *I. angustifolia*, is an evergreen shrub, found in the swamps of North America, from Virginia to Georgia, growing from six to ten feet high. The leaves are linear-lanceolate, with the margin somewhat bent downwards, and serrated, or saw-edged, near the point. The flowers are white, and are produced in June; they are succeeded by globular red berries. It is a distinct and handsome plant, but not very much grown.

The Madeira holly, *I. perado* or *I. maderensis*, is a native of Madeira, where it forms a low tree, with ovate shining leaves, and small white flowers, followed by large red berries. It is a handsome species, and will endure mild winters without protection.

The broad-leaved holly, *I. latifolia*, is a splendid half-hardy evergreen shrub, from Japan; it has ovate serrated leaves, shining above, the edges revolute; the flowers are small and white. In the Epsom nursery this plant has been grown with leaves nine inches long.

The Canary Island holly, *I. canariensis*, is a hardy evergreen tree, growing twenty feet high; the leaves are ovate-lanceolate, acute, flat, shining, and quite entire; the flowers are white, and the berries black.

Besides these, the following may be planted in sheltered situations, against a wall:—I. cuneifolia, I. ligustrifolia, I. chinensis, I. heterophylla, and I. macrophylla.

HOLLYHOCK,—*Althæa rosea.* A malvaceous plant, a native of the East, and very frequently cultivated in gardens for the sake of its ornamental spikes of large and beautiful flowers. The root is biennial, and shoots up one or several very upright, hairy stems, which attain the height of from five to twelve feet. The leaves are cordate at base, and divided into from five to seven lobes. The flowers are subsessile, rose-coloured, and situated in the axils of the superior leaves, thus forming a long terminal spike. From cultivation, many varieties have arisen, bearing flowers, single or double, white, yellow, red, or even almost black.

Hollyhocks excel almost all other ornamental plants at the backs of borders, among shrubs, and in the centre of clumps. Their towering spikes of varied colours form a splendid addition to even the most highly furnished gardens, even with all their present faults; and were the flowers rendered more permanent, and in consequence more brilliant, they would have claims which scarcely any other hardy subjects can boast. They live through all kinds of weather, require no removing two seasons out of three, or even more than that; and they want no stakes, and brave pretty nearly all sorts of weather. The amateur cultivator of seedlings should think of nothing, in his selections, but the brightest colours and the thickest petals. From those with the thickest petals he should save the seed; sow them pretty much about the time that most perennials are sown, June or July; and when they are large enough, plant them out, one foot apart, in rows two feet from each other. Here they must be kept clear from weeds; and the earth between them must be stirred occasionally. They may be continued in this place until they bloom; or if wanted for ornament in the clumps, beds, and borders, they may be planted out where they are required; but there will be many to throw away, as well as a few to keep.

Young hollyhocks of all sorts might be planted in many field hedges to afford bees a second season of collecting their sweets; and, after a wet or cold summer, these autumnal flowers would afford them relief, give them strength to endure the winter, and shorten it to them by preventing their falling too early on their store. A good strong cloth may be made from the fibrous bark of the flower-stalks of the hollyhock. In 1821 about 280 acres of land near Flint, in Wales, were planted with it, in order to convert the fibres into thread, similarly to that of hemp or flax. In the process of manufacture it was discovered that the plant yields a blue dye, equal in beauty and permanence to the finest indigo. The seed-cases should be collected, when ripe, in dry weather, and kept dry, sown in April in beds of light earth, and the young plants removed when they have six or eight leaves each, into nursery beds about twelve inches from each other, and watered, if the season be dry, until they have taken root; then kept free from weeds, and planted out, where they are to remain until October. Seeds sown as soon as ripe in autumn, and planted out early in spring, will sometimes flower a year sooner than could have been obtained from spring sowing.

HOLLY OAK, or HOLM OAK. The evergreen oak. See OAK and ILEX.

HOLM. A haugh or a fenny island. See HAUGH.

HOLM OAK. See OAK and ILEX.

HOLOSTEA. See STITCHWORT.

HOLOSTEUM. A small genus of plants, of the carnation tribe. The umbellated species, *H. umbellatum*, is a beautiful annual-rooted indigen of old walls and similar situations, in some parts of England. Its stem is only 2 or 3 inches high; and its flowers are pink-coloured, and bloom in July and August.

HOLT. A wood or osier-ground.

HOLY-GRASS. See HIEROCHLOE.

HOMALIUM. A small genus of ornamental tropical shrubs, constituting the type of the order Homalineæ or Homalinaceæ. All the plants of this order are handsome evergreen shrubs, with alternate leaves, deciduous stipulæ, and parietal placentæ. Only 8 or 9 species occur in the gardens of Britain; and these are distributed among four genera. Only two species of the genus homalium are known,—*H. racemosum*, a white-flowered, summer-blooming shrub of 6 or 7 feet in height, introduced about 30 years ago from the West Indies,—and *H. Racoubea*, whose roots are employed in Guiana as a remedy for gonorrhœa.

HOMERIA. A genus of beautiful, bulbous-rooted, Cape-of-Good-Hope plants, of the iris order. Nearly a dozen species, all summer-bloomers, have been introduced to Britain. They vary in height from 12 to 40 inches; and the majority have vermilion-coloured flowers, and the rest either yellow flowers or purple flowers. The name Homeria is a compliment to the old Greek father of epic poetry.

HOMESTEAD. A farmery or group of farm-buildings and attached yards and offices.

HONESTY, MOONWORT, or SATIN-FLOWER,—botanically *Lunaria*. A small genus of hardy, herbaceous, ornamental plants, of the cruciferous order. The biennial species, *Lunaria biennis*—called by Linnæus *Lunaria annua*—is a native of Hungary and Austria, and was introduced to Britain in the latter part of the 16th century. Its stem is branching and 3 or 4 feet high; its bark is reddish and hairy; its branches deflect from all parts and from all sides of the stem; its leaves are alternate, cordate, pointed, and a little hairy,—and the lower ones are pedunculate, but the upper ones sessile; its flowers grow in clusters from the sides and top of the branches, and have each four purplish heart-shaped petals, and bloom in May and June; and its silicles are large, flat, two-celled, and moon-shaped, and enclose each two rows of flat kidney-shaped seeds, and, when ripe, are very transparent and have the appearance of discs of white satin. This plant, chiefly on account of the singular character of its silicles, has long been a general favourite in gardens; and an old practice is to cut off its branches when studded with the ripe silicles, and to place them in the chimneys of halls and large rooms, where they continue a long time in beauty. A variety of the biennial species has white flowers. The revived species, *Lunaria rediviva*, was introduced from Germany toward the close of the 16th century; and is not quite so tall as the biennial species, but has a biennial root, and ranks as a herbaceous evergreen.

HONEY. A vegetable product, very similar in its properties to sugar. It is found, in large quantities, in a number of vegetables, is collected by the bee, and is fed upon by many insects. It is always formed in the flower, chiefly at the base of the pistil, and it seems designed to receive and retain the fecundating pollen. Honey differs much in colour and in consistence; it contains much saccharine matter, and, probably, some mucilage, from which it derives its softness and viscosity. Honey very readily enters into the vinous fermentation, and yields a strong liquor called *mead*. There are two species of honey; the one is yellow, transparent, and of the consistence of turpentine; the other white, and capable of assuming a solid form, and of concreting into regular spheres. These two species are often united; they may be separated by means of alcohol, which dissolves the liquid honey much more readily than the solid. Honey has never been accurately analyzed, but some late experiments go to prove it to be composed of sugar, mucilage, and an acid. The honey made in mountainous countries is more highly flavoured than that of low grounds. The honey made in the spring is more esteemed than that gathered in the summer; that of the summer more than that of the autumn. There is also a preference given to that of young swarms. Yellow honey is obtained, by pressure, from all sorts of honey-combs, old as well as new, and even from those whence the virgin honey has been extracted. The combs are broken, and heated, with a little water, in basins or pots, being kept constantly stirring; they are then put into bags of thin linen cloth, and these into a press, to squeeze out the honey. The wax stays behind in the bag, excepting some particles, which pass through with the honey.

Honey is the production of most countries, yet more abundant in the island of Candia, and in the greater part of the islands of the Archipelago, than anywhere else. The Sicilian honey seems to be particularly high flavoured, and, in some parts of the island, even to surpass that of Minorca, which no doubt, is owing to the quantity of aromatic plants with which that country is overspread. This honey is gathered three times in the year, in July, August, and October. It is found, by the peasants, in the hollows of trees and rocks. The country of the lesser Hybla is still, as formerly, the part of the island that is most celebrated for this article. Considerable quantities of honey are produced by the wild bees, in the woods of North America.

Honey is used in preserves and confectionary, and, in its pure state, to put upon bread; also as a demulcent medicine against hoarseness, catarrhs, &c., and externally, as a softening application, to promote suppuration. It is used in its clarified state, to sweeten certain medicines. It is more aperient and detergent than sugar, and is particularly serviceable in promoting expectoration in disorders of the breast, and as an ingredient in cooling and detergent gargarisms. For these, and other similar purposes, it is sometimes mixed with vinegar, in the proportion of two pounds of clarified honey to one pint of the acetic acid, boiled down to a proper consistence over a slow fire, and thus forms the oxymel simple of the shops. It is also impregnated with the virtues of different vegetables, by boiling it in the same manner, with their juice or infusions, till the watery parts have exhaled. It is the basis of several compositions in pharmacy, though in this way it is less used than formerly. It is also used in making mead. When collected from poisonous plants, as *Rhododendron Ponticum*, &c., it partakes of the qualities of the plants. The inferior qualities of honey, and what remains when it is purified, can be used in the preparation of brandy, vinegar, &c.

Honey, as may be easily imagined, was one of the first articles of human nourishment. The gods of Greece were imagined to live on milk and honey (ambrosia). Aristotle, Celsus, Pliny, Ælian, and probably the ancients in general, did not know where honey originally came from; they thought it was a dew which fell from heaven. The juice of the flowers, they believed, produced only the wax. Hence we find the honey flowing from the trees in great abundance, in the descriptions which the poets give of the golden age. In the Bible, we find mention made of bees'-honey, grape-honey (must, boiled to a sirup, and still used), and tree-honey, which is found upon the leaves of certain trees and shrubs, having been thrown out by certain insects. In all the works on agriculture left by the ancients, we find much importance attached to honey and the care of bees. The ancients also ascribed medicinal powers to honey. In their domestic concerns, they used it as we do sugar, and made of it and good old wine a mixture very much liked. This was distributed among the soldiers when they returned in triumph.

HONEY-BERRY,—botanically *Melicocca*. A genus of small, evergreen, tropical fruit-trees, of the soap-berry tribe. Three species, the two-paired, the olive-shaped, and the panicled, have been introduced to British hothouses from the West Indies; and one species, the three-paired, from Ceylon; and several other species are known. The pulp of the fruit is said to be well-flavoured and pleasantly esculent; and the fine gout of it is alluded to in both the popular and the scientific names of the genus.

HONEY-COMB. A waxen structure, full of cells, framed by the bees, to deposit their honey and eggs in. The construction of the honey-comb seems one of the most surprising parts of the works of insects; and the materials of which it is composed, which, though evidently collected from the flowers of plants, yet do not, that we know of, exist in them in that form, have given great cause of speculation. The wax is secreted, by the peculiar organization of the insect, in the form of small and thin oval scales, in the incisures or folds of the abdomen. The regular structure of the comb is also equally wonderful. The comb is composed of a number of cells, most of them exactly hexagonal, constructed with geometrical accuracy, and arranged in two layers, placed end to end, the openings of the different layers being in opposite directions. The comb is placed vertically; the cells, therefore, are horizontal. The distance of the different cakes of comb from each other is sufficient for two bees to pass readily between them, and they are here and there pierced with passages affording a communication between all parts of the hive. The construction of the cells is such as to afford the greatest possible number in a given space, with the least possible expenditure of material. The base of each cell is composed of three rhomboidal pieces, placed so as to form a pyramidal concavity. Thus the base of a cell on one side of the comb is composed of part of the bases of three on the other. The angles of the base are found, by the most accurate geometrical calculation, to be those by which the least possible expense was required to produce a given degree of strength. The sides of the cells are all much thinner than the finest paper; and yet they are so strengthened by their disposition, that they are able to resist all the motions of the bee within them. The effect of their thrusting their bodies into the cells would be the bursting of those cells at the top, were not these well guarded. But, to prevent this, the creatures extend a cord, or roll of wax, round the verge of every cell, in such a manner that it is scarcely possible they should split in that particular part. This cord, or roll, is, at least, three times as thick as the sides of the cell, and is even much thicker and stronger at the angles of the cells than elsewhere, so that the aperture of each cell is not regularly hexagonal, though its inner cavity be perfectly so. The cells which have served or are to serve for the habitation of the worms of the common and of the male bees, are often made also, at other times, the receptacles of honey; but, though these are differently made to serve either use, there are others destined only to receive honey. The celerity with which a swarm of bees, received into a hive where they find themselves lodged to their minds, bring their works of the comb to perfection, is amazing. There are vast numbers at work all at once; and, that they may not incommode one another, they do not work upon the first comb till it is finished, but, when the foundation of that is laid, they go to work upon another, so that there are often the beginnings of three or four stories made at once, and so many divisions allotted to the carrying on the work of each.

HONEY-DEW. A clear, colourless, viscid, sweet liquid, found often on the leaves of plants, and sometimes on the ground beneath them. It tastes somewhat like honey; it is perfectly fluid in warm weather, but is somewhat consolidated or candied in cold weather; and, when evaporated from paper, it leaves a gummy mark, not unlike that left by solution of gum-arabic. It appears sometimes in blotches upon leaves; sometimes in suffusion over the whole surface of the lower leaves; sometimes in globular drops, of various sizes, from that of a pin's head to that of a currant or even of a grape; sometimes in elongated drops pendent on the points of leaves; sometimes in sprinklings on the ground below trees; and sometimes in mimic local showers, or in such extraordinary quantity as almost literally to moisten the soil beneath lime-trees, beech-trees, or some other particular trees. "Honey-dew," says Professor Rennie, "is sometimes ejected in considerable quantity; and more than once I have mistaken it for drops of rain; and Major witnessed an instance in which a causeway under some sycamores infested with plant-lice was sprinkled with honey-dew similar to a shower of rain." "In warm weather," says Mr. Main, "it sometimes actually falls in showers, as was witnessed by the Abbé Boissier de Sauvages, and which I have also observed repeatedly, and even in such quantity as to saturate the dust of a road under a large lime-tree." But, in all ordinary instances, it appears merely upon leaves, and only in such quantity as to seem like exudations on their surface. All ants and wasps and some bees are extremely fond of it; and the bees sip it most when in quite a liquid state; and the comparative plenty or scarcity of it in any season has been observed to control, in a very great degree, the produce of the apiary. See the articles ANT and BEE.

Pliny called honey-dew "the sweat of the heavens" and "the saliva of the stars;" and questioned whether it was not a liquid resulting from the purgation of the air; and even some modern naturalists have supposed that it is generated in the atmosphere, and falls like dew or small rain upon plants. But it is never seen on the highest leaves of a plant; and is always most abundant on lower leaves overshadowed by upper ones, or even on the ground beneath the shade and shelter of the whole plant; and it occurs also on plants in glazed-houses, where it could not possibly have fallen from the atmosphere.

Dr. Mason Good, in his "Study of Medicine," ascribes it to a peculiar haze or mist loaded with miasmata, sweeping slowly through a plantation, and stimulating the leaves to make a morbid, viscid, saccharine secretion; and he supposes, in the case of the hop-plant, that the *Aphis humuli* finds the stimulated and secreting leaves a suitable resort for incubation, and is induced to deposit on them myriads of its little ovules, there to be hatched and cherished as in an appropriate nidus. But the mouth of that insect has not such a structure as would enable it to feed on a viscid liquid; and the minute dots which Dr. Good supposed to be ovules are really the cast skins of the insects; and the leaves and shoots which abound with honey-dew are not, as he supposes, in an exhausted and morbid condition, but perfectly healthy and vigorous.

Another writer ascribes honey-dew to an electric change in the atmosphere; and states his theory with special opposition to the opinion, that honey-dew is a deposit or excrementition of aphides. "Last summer," says he, "we investigated the phenomena with great care. The weather had been parched and sultry for some weeks previous; and the honey-dew prevailed to such an extent, that the leaves of the currant, raspberry, &c., in the gardens literally distilled from their tips a clear limpid honey-dew, excreted from the plant; for the phenomena was observable on those plants that were entirely free from aphides, and so copious was it, where these insects were found, that, had their numbers been centuple, they could not certainly have been the source of the supply. The question with me, however, was set at rest by applying a lens, having previously washed and dried the leaf with a sponge; for in this case, the immediately excreted globules became apparent." But, in order to establish or even render plausible the theory of the production of honey-dew by special electric change, there ought to have been nice, careful, scientific observation of the electric conditions of the atmosphere,—of the degrees and kinds of atmospheric electrical phenomena,—of the relations of the fluctuating electricity of the atmosphere to the polar electricity of the plants or to their peculiar capacities of conduction, —of the precise electrical conditions which were contemporaneous with the production of the honey-dew,—and of the state of the plants, in reference to the copiousness, the paucity, or the absence of honey-dew, at as many other times as possible when the same or similar electrical conditions occurred. But no such observations appear to have been made; and the gross and petty observations recorded in lieu of them are worthless. The existence of honey-dew on some leaves where no aphides could be seen only proves, either that all the aphides had left these leaves, or that they made their deposits from leaves above; and the extreme copiousness of honey-dew on other leaves where comparatively few aphides could be seen, only proves the same thing,—either that the great body of the aphides had left these leaves, or that they made their deposits from leaves above; for, as M. Sauvages, Professor Rennie, and other observers have well ascertained, the aphides are careful to eject the honey-dew to a distance from the leaves or spots on which they are feeding. As to the washing and drying of a leaf, and observing it afterwards to exude globules, the probability or almost the certainty is that the parenchyma had been wounded either by the beaks of the aphides, or by the process of washing, or in some other way, and that it, in consequence, exuded globules of sap which were mistaken, through the lens, for globules of honey-dew. "I have now in my study," says Professor Rennie, "a plant of the Chinese chrysanthemum, the young shoots of which have swarmed with aphides all the winter, and the leaves below are covered with honey-dew. I tried the experiment of wiping it off from a leaf; but no more was formed when it was protected by a piece of writing-paper from the aphides above; while the writing-paper became sprinkled all over with it in a few hours."

Mr. Swainson regards honey-dew as, in a general sense, one of the diseases of vegetables. Linnæus ascribes the honey-dew of the hop-plant to a morbid state of the organism, arising from the injury of the roots by the caterpillar of the *Hepialis humuli*. Dr. Withering adopts the fanciful and far-fetched theory of Linnæus, and ludicrously recommends, as a preventive of honey-dew in the hop, to cover up the roots of the plant with stones. White, with exquisite absurdity, ascribes honey-dew to the aeriform dissipation and subsequent condensation and fall of the volatile oils of flowers. "The reason of it," says he, "seems to be, that, in hot days, the effluvia of flowers are drawn up by a brisk evaporation, and then in the night fall down with the dews with which they are entangled." Sir J. E. Smith contends that, in at least some cases, honey-dew is certainly an exudation of plants themselves; and he alleges that the honey-dew of the beech-tree, in particular, is a sweet and glutinous coating of similar flavour to the fluid obtainable from the trunk, and that it appears simply in consequence of the action upon the leaves of an unfavourable wind. The Rev. Mr. Keith agrees with Sir J. E. Smith, and says, "It is difficult to conceive how the dropped excrements of aphides should coat a leaf so regularly as leaves are sometimes coated; but if we regard the coating as an exudation, the difficulty vanishes. In the former case, the coating may become the cause of disease; in the latter case, it may be the consequence of disease." Mr. Keith thinks, too, that there are cases of saccharine exudation not at all connected with disease; and he refers for illustration to the apparently analogous cases of the glutinous exudation on the leaves of the lime-tree, the waxy exudation on the leaves of the rosemary, the resinous exudation on the leaves of the *Cistus creticus*, the saccharine exudation on the leaves of the orange-tree, and the watery exudation, in hot and calm weather, from the leaves of the plaintain-tree, the poplar, and the willow,—all referable, as he alleges, to the ejection of superfluous nourishment in the course of the healthy elaboration of the sap. But most of these are instances, not of occasional exudation, but constitutional secretion,—and so possess no analogy whatever to the case of honey-dew; and even such as are occasional occur under conditions widely different from those in which honey-dew is produced. As to the effect of the "unfavourable wind" upon beeches, the very "unfavourableness" of the wind may not improbably consist in its wafting to the trees a cloud of aphides. See the article Aphis.

The most strenuous of all the erroneous opinions respecting the nature of honey-dew assert it to be simply extravasated sap. See the article Extravasation. Mr. George W. Johnson, for example, classes honey-dew with the extravasations from canker, from plethora, from wounds, and from unnatural contraction of the circulatory vessels,—pronounces it an unnatural condition proceeding from the combined heat of the atmosphere and dryness of the soil during the drought of summer,—and says, "It is somewhat analogous to that outburst of blood which, in such seasons, is apt to occur to man, and arises from the increased action of the secretory and circulatory systems to which it affords relief; but there is this great and essential difference, that, in the case of the plants, the extravasation is upon the surface of the leaves, and consequently in proportion to the abundance of the extruded sap is their respiration and digestion impaired." But scarcely any reasoning and no observation of any consequence are adduced in support of this bold and complicated opinion; and even Mr. Johnson himself incidentally, though very distinctly, asserts his alleged extravasated sap from the effects of summer drought to be only one of *several kinds* of honey-dew. "The error," says he, "into which writers on this subject appear to have fallen, consists in their having endeavoured to assign the origin of *every kind* of honey-dew to the came cause." Now all correct phytologists justly regard honey-dew as a thing of only *one kind*,—as simply and solely that clear, viscid, saccharine substance which we described at the beginning of this article; and they naturally enough, and quite philosophically, assume it to proceed from only one cause. We readily concede, however—what, indeed, is quite apparent from several of the theories which we have stated, and especially from Mr. Johnson's—that some observers appear to have mistaken occasional or incidental watery exudations of the ordinary sap of plants for real honey-dew; and, in whatever instances they have done so, the liquid which *they* call honey-dew must, of course, be assigned to the wounding of the plants' tissues or to whatever else occasioned the exudations.

Honey-dew, unless in quite perverted senses of the word, is entirely the deposit of minute insects. "If I am not greatly mistaken," says Mr. Main, "there is a small fly, perhaps a species of the genus thrips, which emits a sweet clammy liquor on the leaves of the trees it lives on. I am led to believe this, because on many of the trees, as oak, birch, sycamore, and lime, when infested with honey-dew, there was always a great concourse of those thripses as well as aphides." The aphides, however, even in Mr. Main's opinion, are the chief producers of honey-dew; and, in the opinion of many of the most eminent naturalists, are the sole producers. It accompanies the flights and colonizations of the aphides; and Professor Rennie, by means of a lens, actually saw them ejecting it. They differ very widely, in some principal parts of their economy, from all other animals; and cannot be regarded with greater wonder as ejectors of a viscid saccharine liquid, than as propagators of their species through a series of progenies as the effect of a single impregnation. They live wholly on liquid food, and discharge no solid excrements, and are provided, not only with an anal vent, but with two long, horn-like rump tubes for ejecting such refuse or portion of their food as is unnecessary for their nourishment. If they were regarded as forming the saccharine matter of the honey-dew in their interior organism, they no doubt would be a notable exception to the otherwise uniform vegetable origin of all saccharine substances; but, when their peculiar economy of feeding and structure is considered, they may easily be supposed to act as simple living ducts of the saccharine matter from the vegetable vesicles in which they find it to the surface of the leaves on which they deposit it; or, in other words, they receive the saccharine matter ready made in their liquid food, and simply part with ndecomposed portions of it in their ejections. The particular species which deposit most honey-ew are *Aphis brassicæ*, *Aphis rapæ*, *Aphis ulmi*, *Eriosoma populi*, and *Eriosoma mali*.

Honey-dew possesses an incidental value as n occasional and sometimes a principal food of bees. "The honey-gathering," says a writer in he Gardener's Gazette, "has indeed been very bad this year; in most parts of the country, the average quantity of honey taken from each hive never exceeded one pound; but at one of my apiaries, where there are large woods of oak, and commons of heath and wild thyme, there was a honey-dew every morning for 13 days in August, and where none of my stocks weighed in October ess than 25 lb., and one of this year's swarms 32 b." Curtis even thought it possible, if the ants, wasps, and flies, could be prevented from devouring the honey-dew, "almost as fast as it was deposited," to collect it in considerable quantiies and convert it into the "choicest sugar and sugar-candy."

But honey-dew is, on the whole, a serious evil, partly by disfiguring the foliage of fruit-trees, and stickily attracting dust to plums and cherries, but chiefly by arising, through the medium of the aphides, from an enormous abstraction of the healthy juices out of plants. The only effectual preventive or cure of it, of course, is to ward off or destroy the aphides; and some of the chief neans of dealing with the several species are noticed in the article Aphis. But a weak solution of common salt applied to the soil around nfected trees, was also found by Mr. George W. Johnson to be effectual; and this may possibly be a very eligible appliance, on account of not only repelling or poisoning the aphides, but likewise curing any of the occasional exudations of sap which Mr. Johnson seems to have confounded with honey-dew. He says: "I have seen plants of various kinds which have been treated with a weak solution of common salt and water totally escape the honey-dew, where trees of the ame kind, growing on the same plot of ground, not so treated, have been materially injured by ts ravages. I think, however, that the solution which has been sometimes employed for this purpose is much too strong for watering plants. I have always preferred a weaker liquid, and am of opinion that one ounce of salt to a gallon of water is quite powerful enough for the intended purpose. I am in doubt as to the correctness of Knight's opinion as to the mere water having any material influence in the composition of uch a remedy, since I have noticed that standard fruit-trees, around which, at a distance of ix or eight feet from the stem, I had deposited, at a depth of twelve inches, a quantity of salt to promote the general health and fruitfulness of he tree, according to the manner formerly adoptd to some extent in the cyder counties for the pple orchards; that these escaped the honey-dew, which infected adjacent trees just as well as those which had been watered with salt and water. Hitt, who was a practical gardener, and published his work upon fruit-trees in 1755, after describing the honey-dew, and his ideas of its effects upon fruit-trees, says, 'If the season be wet, spread common salt over the border, about eight ounces to each tree, for the more salt the juices contain, which form the young plants, the more smooth and compact their leaves will be, and thereby less subject to the penetration of the honey-dews than when they are composed of juices more watery.' Mr. Knight's experiments were made with the view of preventing the blue mildew, with which pease and some other crops are usually annoyed, especially the early and late sown; and by keeping the rows well-watered, he perfectly succeeded, employing sometimes water alone, and on other occasions water in which 'a small portion of common salt was dissolved. By this process I have constantly succeeded,' he remarks, 'in preserving the health of my autumnal crop of pease;' and although the applications were made to provide against the injuries of another disease, yet they still certainly in some degree support the conclusions drawn by Hitt and myself as to the preventative power possessed by a weak saline solution."

HONEY-FLOWER,—botanically *Melianthus*. A small genus of ornamental, evergreen, Cape-of-Good-Hope shrubs, of the rue tribe. The greater species, *Melianthus major*, was introduced to Britain in the latter part of the 17th century Its root is ligneous, and spreads far on every side; its stems are numerous, hollow, and from 6 to 12 feet high, and are ligneous in the lower part, but herbaceous at the top; its leaves grow from the herbaceous part of the stems, and embrace them with their base, and are large and pinnate,—each having 4 or 5 pairs of very large and deeply jagged leaflets, and a terminating odd one; and its flowers grow in longish spikes from the top of the stems, and have a chocolate brown colour, and are shaped somewhat like the lip-flowers, but with four narrow petals, and bloom from May till July. Two other species, the smaller and the tufted, the former brown-flowered, the latter yellow-flowered, and neither more than about a yard high, have been introduced.

HONEY-GARLIC,—botanically *Nectaroscordum*. A recently constituted genus of plants, of the asphodel family. It is nearly allied to the onion or true garlic genus. The Sicilian species, *N. siculum*—called by some botanists *Allium siculum*—was introduced to Britain about 15 years ago from Sicily. Its root is bulbous and hardy; its stem is 3 or 4 feet high; and its flowers are various-coloured and ornamental, and bloom about midsummer.

HONEY LOCUST-TREE. See Gleditchia.

HONEYSUCKLE,—botanically *Caprifolium*. A genus of ornamental twining shrubs, constituting the type of the natural order Caprifoliaceæ. This order is eminently beautiful, and of

considerable extent. One division, represented by the dogwood, consists of handsome bushes, with cymes of white flowers; and another division, represented by the common honeysuckle, consists of twiners and erect shrubs, with clusters of white, yellow, orange, purple, scarlet, or yellow and red, fragrant, trumpet-shaped flowers. About 120 hardy species, and upwards of a dozen tender ones, occur at present in the gardens of Britain, and are distributed among caprifolium, lonicera, viburnum, cornus, sambucus, and six other genera. All love shady situations, and few can endure very severe cold. All have some degree of astringency in their bark, and two or three are somewhat powerfully medicinal. Many of both divisions are brilliant ornaments of the shrubbery; and a considerable number are highly popular favourites, and very extensively diffused.

The genus caprifolium comprises two indigenous species, five or six introduced evergreen species, and five or six introduced deciduous species. All are beautiful; none are less than six feet high, and some are so high as 20 or 25 feet; the majority of the evergreens are slightly tender, and all the other species are hardy; and some have scarlet flowers, some yellow, some orange, and a good number a combination of red and yellow. The majority thrive in any kind of garden soil; and nearly all may be readily propagated from cuttings. We can afford to take brief special notice of only the two indigenous species.

The common, or Italian, or pale perfoliate honeysuckle, *Caprifolium italicum*—called by Linnæus *Lonicera caprifolium*—grows wild in the woods and thickets of some parts of England, but is not common. Its stem is woody, cylindrical, smooth, and somewhat branched, and twines from left to right, and, when duly supported, attains a height of 10 or 12 feet; its leaves are opposite, obovate, entire, and smooth; its flowers grow in one or more six-flowered axillary whorls, and are about two inches long and highly fragrant, and have a yellowish colour with a bluish tube, and bloom in May and June; and its berries are elliptical, and have a tawny orange colour. The leaves are sometimes used in gargles.—Some varieties of this plant were very long ago introduced to Britain from Italy, and occasioned the species, in spite of its indigenousness, to be called Italian. The best known varieties are the early white, the early red, the late red, the yellow, and the evergreen. The last of these is quite distinct from the *Caprifolium sempervirens*, or evergreen trumpet honeysuckle, introduced nearly two centuries ago from North America; and it is a stronger shooter than any of the other varieties of the common honeysuckle, and has large, thickish and sheathing leaves, and sometimes prolongs its fine bloom of red pale-striped flowers till the end of autumn.

The woodbine or English honeysuckle, *Caprifolium periclymenum*, grows wild all over England and many parts of Scotland, in hedges, groves, and thickets; and is one of the most charming and generally loved of our native plants. Its stem twines like that of the preceding species, and has opposite branches, and, with due support, can readily attain a height of 20 feet; its branches are often very weak and trailing; its leaves are distinct from one another, and somewhat succulent, and of a darker green than those of the common honeysuckle; its flowers are variously yellow, buff-coloured, red, and yellow and red, and bloom from May till July, and are not nearly so beautiful as those of any of the garden honeysuckles; and its berries are almost globular, and have a dark red colour, and are disgustingly bitter and often roughish. Goats greedily eat the leaves, and either from this circumstance or from the goat-like climbing habit of the plant arose the name Caprifolium, which signifies 'goat-leaf.' The best known varieties of the woodbine are the evergreen, the late red, the midsummer, the long-blooming, the oak-leaved, the variegated, and the Dutch. The last of these is probably the worthiest of cultivation. Its branches have a smooth purplish bark, and may be known from those of the other varieties even in winter by their red swelled buds; and its flowers are produced in bunches at the ends of the branches, and have a red exterior, a yellowish interior, and a delightful odour. The English honeysuckle is the true woodbine of the poets; yet is mistaken by Milton for the eglantine.

HONEYSUCKLE (FLY). See FLY.

HONEYSUCKLE (FRENCH). See HEDYSARUM.

HONEYSUCKLE-TREE. See BANKSIA.

HONEYSUCKLE (TRUMPET). See LONICERA.

HONEYSUCKLE (UPRIGHT). See AZALEA.

HONEYWORT,—botanically *Cerinthe*. A genus of hardy, ornamental, herbaceous plants, of the borage family. The greater honeywort, *Cerinthe major*, grows wild in Germany, Italy, and the south of France, and was introduced to Britain toward the close of the 16th century. Its root is annual; its stem is smooth, branching, about 18 or 24 inches high, and reflexed at the top somewhat like that of the turnsole; its leaves are ovate-oblong, rough, and of a sea-green colour spotted with white, and embrace the stem with their base; the flowers grow at the end of the branches, and are long, tubulous, and blunt and greatly enlarged at the top, and have a yellow colour shading off into purple, and secrete a mellow liquid of which bees are very fond, and bloom from July till August; and the seeds ripen in August and September,—and, if not taken away as soon as they become black, they drop to the ground, and begin to germinate on the occurrence of the first moist weather. Three other annual species and a biennial one—one of the former, *C. retorta*, a curious twiner—have been introduced to Britain. The popular name honeywort alludes to the sweet, bee-feeding secretion of the flower; and the botanical name Cerinthe alludes to an accompanying secretion of wax, with which the bees are somewhat largely supplied.

HONEYWORT,—botanically *Sison*. A genus of herbaceous plants, of the umbelliferous order. The amomum, or hedge honeywort, or bastard stone-parsley, *Sison amomum*, is an annual weed of the calcareous districts of Britain. It usually occurs on somewhat moist chalky or marly ground beneath hedges. Its root is tapering, and has many side fibres; its stem is erect, tough, and about 3 feet high; its branches are numerous, alternate, stiff, and wiry; its leaves are pinnate, smooth, and dark green, and have their odd leaflet lobed; its umbels are numerous, terminal, and solitary, and consist each of 4 unequal rays; its flowers are whitish cream-coloured, and bloom in July and August; and its seeds, when ripe and dried, are aromatic and pungent. All parts of the plant in a green state, and especially the seeds when bruised, emit a disgusting odour similar to that of bugs.

The corn honeywort, *Sison segetum*, is an annual weed of moist fields in the chalk districts of England. Its root is small, tapering, and very tough; its stems are spreading, rushy, branched, striated, and about 18 or 24 inches high; its radical leaves constitute the chief part of its foliage, and are long, narrow, and pale greyish green, and grow on long footstalks; and its flowers are whitish flesh-coloured, and bloom in July and August.

The inundated species, *Sison inundatum*, is an annual weed of the ditches, pools, and flooded grounds, of some parts of Britain. Its stems are procumbent, branched, leafy, somewhat stoloniferous, and about a foot high; its leaves are pedicelled, alternate, oblong, pinnate, and somewhat succulent,—and the submerged ones very compoundly divided; its flower-stalks grow opposite to the leaves, and are nearly as long, and terminate each in a pair of stalked umbels; and its flowers grow in five on each umbel, and are whitish-coloured, and bloom in May and June.

The whorl-leaved honeywort, *Sison verticillatum*—regarded by some botanists as a water-parsnip, under the name of *Sium verticillatum*—grows wild in the salt marshes and moist meadows of various parts of Britain. Its roots are perennial, fusiform, and fleshy; its stem is solitary, erect, cylindrical, striated, almost naked, about 12 or 15 inches high, and slightly corymbose at the top; its radical leaves constitute its principal foliage, and grow on short, sheathing footstalks, and are compoundly pinnate, each consisting of numerous pairs of sessile, deeply cut or linearly-divided leaflets, so arranged as to appear like a series of whorls; and its flowers are whitish, but have purplish anthers, and bloom in July and August. This species is almost the only one which can be regarded as ornamental.

Five or six species, some annual, and some perennial, have been introduced from Siberia, Continental Europe, and North America, and a number of other species are known. The genus is chiefly remarkable for the odorous, aromatic, and pungent properties of the seeds of some of its species,—properties which bring it into somewhat close alliance with the carums, the anethums, and other aromatic unbellifers.

HOOD-SHEAF. A sheaf of corn, in the harvest field, placed sloping along the tops of two or more pairs of other sheaves as a covering from the weather.

HOODED-MILFOIL,—botanically *Utricularia*. A genus of curious, floating, aquatic plants, of the tribe Lentibulariæ. Three perennial-rooted, yellow-flowered species, the common, the lesser, and the intermediate, inhabit the ditches, pools, and other stagnant waters of various parts of Britain; and about 60 foreign species, all of similar habits to the British ones, are known to botanists. The thin stems or leaves are finely divided; and the flowers stand on a central footstalk a few inches above the water, and bloom about midsummer. The contrivances for floating consist of a kind of bladders, attached to the thin stems; and they sometimes occasion the plants to be popularly called bladderworts.

HOOF. See Foot.

HOOK-BONES. Bones in the hind-quarter of cattle.

HOOPOE, or Puet,—scientifically *Upupa*. A genus of passerinous birds of the tenuirostres family. Three species are known; and all have on their head an ornamental crest or double range of long feathers, which they can erect at will. The common species, *Upupa epops*, is a visitant of Britain, and one of the most remarkable of our feathered beauties. Its total length is 12½ inches; its predominant colour is a vinous red; its wings and tail are black; and its wing-coverts have two, and its wing-quills four, transverse white bands. It builds its nest in the hollows of trees, or in similar situations; and feeds on beetles and other insects, which it finds in humid earth. It is a rare bird as to numbers, and yet a somewhat common bird as to diffusion; for it is occasionally seen in almost every county of the south and the east. It usually visits Britain in autumn; and when once seen, it ever after is very readily recognised.

HOOSE. See Catarrh.

HOOVE, Hoven, or Blown. An extremely flatulent distension of the rumen, paunch, or first stomach of cattle or sheep. It is accompanied with excessive pain, and if not soon reduced, it speedily proves fatal.

By far the most common cause of hoove is a surfeit of clover, turnips, green gramineous herbage, or other rich and succulent food, after a season of feeding on poor pasturage, or especially on dry and somewhat innutritious fodder. Green food is naturally liable to pass speedily into fermentation, and to let off a large portion of its elements in the gaseous form; it is specially subject to this process when shut up in any vessel, and steadily acted on by heat and moisture; and it, therefore, passes readily and powerfully into it in the hot, moist, close paunch of a ruminating animal, whose immediately preceding habits of feeding have not involved the encountering and resisting of fermentation. Or, in some cases, the green food would merely macerate and not ferment, if it were eaten in moderate quantity; but from its novelty and gratefulness, it is devoured in such excess as to overload the paunch, to obstruct its functional power, and to induce such chemical action as is due merely to the heat and moisture.

No farmer or cattleman ought to be so inattentive as to allow the risk of hoove from change of food. Cattle ought not to be sent all at once from poor pasture to rich grass, or from straw to clover, or from dry provender to succulent roots; or, at all events, they ought not, for some days, to be allowed their full will of the change. Even the simple precaution of alternating them a few times between the rich food and the straw-yard, so as to curb their appetite and give pauses to the stomach, might be a sufficient preventive. A cordial drink is, on some farms, given to cattle, especially to greedy ones, before turning them into a fresh pasture; but though this may prevent hoove, it tends to induce other diseases; and a cordial of any kind, except in cases of downright disease, and quite appropriate to its peculiar mode of action, ought always to be avoided. See the article Cordial.

Hoove sometimes arises from general debility in the stomach, without any such specially exciting cause as a change of food; it is also a frequent accompaniment of fevers and other diseases which affect the powers of digestion; and it occasionally so greatly aggravates a case of difficult parturition, that the rumen must be punctured before the calf can descend far enough into the pelvis to be capable of extraction. But in almost all instances in which it arises from debility or fever, it is symptomatic rather than primary, and is much less violent than when it arises from a surfeit of green food, and can be only alleviated by direct appliances, and must eventually be subdued by a sanatory treatment proper to the whole system.

An animal seized with hoove seems oppressed, ceases to eat or to ruminate, stands almost still, breathes heavily, moans, and becomes exceedingly disturbed at the flanks, and especially at the left flank immediately opposite the rumen. An occasional eructation, of a sour or fetid kind, accompanies the progress of the distension; but no eructation is possible after the distension is complete. If relief be not afforded, inflammation is induced, the brain becomes affected, the eye protrudes, the tongue is pendulous, the back is bent, and the animal becomes insensible, falls, struggles, and dies.

Driving the animal about, so as to keep him in constant motion, is very generally recommended in cases of hoove; but though suitable enough for sheep, it is often a dangerous remedy, and seldom an effectual one, for cattle. The dashing of pails-full of cold water is sometimes practised, and frequently has the effect of dissipating the flatus by violent eructation, but always incurs a risk of bursting the rumen and killing the animal. The plunging of a lancet or a pocket knife into the paunch, at the spot where it presses against the flank midway between the lowermost rib and the haunch-bone, has sometimes been practised with success,—the wound being either left to heal of itself, or closed up, after a little while, with a slip of adhesive plaster; but this operation, even when carefully performed, is very liable to let a portion of the contents of the rumen fall down among the intestines, and set up there a dangerous or fatal inflammation. Even a bold, broad cut, such as to admit the hand, and allow of the mechanical cleaning out of the rumen, has been successfully performed; but this is both dreadfully violent and exceedingly precarious. The thrusting of a flexible stick down the throat into the rumen has also been tried; but this does not afford way enough for the escape of the gas, and may occasion injury or positive rupture to some of the organism. Numerous medicinal agents, such as vinegar, ammonia, oils, and alkalies, have been recommended and tried; but in bad cases, none of them can obtain entrance to the rumen; and even in mild or practicable cases, the vinegar would be mischievous, and the others are too feeble in their mode of action to give sufficiently prompt or ample relief.

The first appliance, in a proper or enlightened treatment of hoove, is to bring off the free gas from the rumen by means of the probang. See the article Probang. But as the subsequent appliances are designed to prevent the evolution of more gas, or to correct the tendency of the fermenting food in the rumen to resolve itself into an aeriform condition, they may be either chemical or mechanical or both according to the particular exigencies of each case. The stomach-pump may be used either to wash out the fermenting juices from the contents of the rumen, or to provoke the ejection of both the juices and the solids by vomiting. See the article Stomach-Pump. Such a medicine as hartshorn or sulphuric ether or lime water may, in any ordinary case, be administered; and when the probang cannot be had, the use of the medicine will generally require to be accompanied by an incision with the trochar. See the article Trochar. But incomparably the best medicinal appliance known is chloride of lime. Two drachms of this powder may be dissolved in a quart or three pints of water, and thrown into the rumen by means of the stomach-pump. The chlorine of the chloride parts from the lime and combines with the hydrogen which constitutes the great bulk of the distending gas,—it combines both with the ready-formed hydrogen in the rumen and with the nascent hydrogen afterwards evolved from the fermenting contents; and it gives instant relief by the great diminution of volume which attends the chemical change; and though the lime left by the chlorine is a caustic substance, and the muriatic acid resulting from the combination of the chlorine and the hydrogen is a dreadfully corrosive one, yet—by a beautiful provision of the all-wise and all-benevolent Framer of the elements and the laws of the universe—these two substances instantly rush into a saturating union with each other, and form an innocuous, neutral salt, the muriate of lime. When a case of hoove is dealt with before it becomes very bad, the probang and the chloride of lime will rarely be found ineffectual; and not unless these cannot be had, or are not timeously used, ought a thought to be entertained of using even the trochar, and far less the lancet or the knife.

A tendency to a return of the disease will for some time exist, and must be counteracted by medicine and suitable feeding. Immediately after the distension has ceased, a pound of Epsom salts, accompanied with some such aromatic as an ounce of powdered caraway seed and half an ounce of powdered ginger, ought to be administered; and on each of several succeeding mornings, a dose of four ounces of Epsom salts, half an ounce of powdered ginger, and two ounces of powdered caraway, ought to be given. For some little time, a daily mash ought to be given; and for a considerable period, no stronger or fuller raw feeding should be allowed than short bare pasture. But if an ox recovered from hoove happen to be in tolerably good condition, the most economical treatment of it may be to send it, with all convenient speed, to the shambles.

Sheep attacked with hoove may, in all mild cases, be, in the first instance, gently and steadily driven hither and thither; and if they be not relieved by this means—but especially if they appear to become worse—they ought, in all respects, to be treated on the same principles as hoven cattle. But care must be used when driving them about, that they be not startled or hurried or over-driven; and if ulterior measures become necessary, and neither probang nor stomach-pump can be had, the effect of thrusting a knob-headed stick down the œsophagus ought to be tried, before having recourse to the cruel and hazardous remedy of making an incision into the rumen.

HOP,—botanically *Humulus*. A hardy, perennial-rooted, twining, herbaceous plant, of the nettle order. It constitutes a genus of itself, and is specifically designated *Lupulus*. Its popular name is an abbreviation of the Saxon word *hoppan*, signifying 'to climb.' Its botanical generic name is formed from the Latin word *humus*, signifying fresh earth, and alludes to the plant's habit, when unsupported by props or poles, of creeping along the ground; and its botanical specific name is formed from the popular name *Lupus salutarius*, which it anciently bore among the Romans, and which, according to Pliny, was given it because it grew among the willows, and, by its twining and choking mode of growth, proved as destructive as a wolf to a flock. The ancient British name of the plant was *Llewig y llaidd*, and signifies the 'bane of the wolf.'

Botanical Description of the Hop.—The hop plant belongs, in the Linnæan arrangement, to the class Diœcia and the order Pentandria; or, in other words, its male and its female are different individuals, and the number of its stamens is five. The root sends up many stems. The stems are rough, angular, striated, and flexible, and twine spirally from left to right, up poles or other erect supports, to the height of from 12 to 20 feet. The leaves are petiolate, opposite, heart-shaped, serrated, either entire or lobed, of a dark green colour, and scabrous with minute prickles. Two stipules occur at the base of each petiole; and are interfoliaceous, entire, smooth, and reflexed. The flowers are axillary and furnished with bracts. The male flower, or flower of the male plant, grows in clusters somewhat like the blossoms of the common currant; and has a calyx of 5 oblong, concave, obtuse sepals,—no corolla,—5 capillary and very short filaments,—and vertical, oblong, two-celled anthers, opening by two terminal pores. The female flower, or flower of the female plant, is a cone, catkin, or strobile of many membranaceous scales, and has an ovate form and pendulous habit, and presents a loose general resemblance to the cone of a fir or pine; the scales are imbricated, concave, tubular from being rolled in at the base, of a pale greenish colour, and two-floreted; the germen is superior, minute, and oblong; the styles are two, awl-shaped, spreading, and downy; the stigmas are simple; and one seed is attached to the base of each enlarged, membranaceous, dry scale, and is round, flattish, of a brown bay colour, surrounded with a sharp rim, and compressed at the tip.

Though only one species of the entire genus, and only one variety of the male plant, are known, yet several very distinct varieties of the female plant are in cultivation. Three varieties are mentioned by Miller as common in his time,—the oval hop, the long white hop, and the long, square, garlic hop. The principal varieties at present cultivated in Kent, are the goldings hop, grown on the ragstone of Middle Kent,—the Canterbury grape hop, grown on the ragstone, chalk-subsoil lands, and other rich soils of Eastern Kent,—and the Mayfield grape hop, grown on all kinds of good or dry soils, and particularly on dry limestone lands throughout the several hop districts of the county. Two varieties, called Jones's hop and the golden-tips hop, are grown in the wealds of Kent and Sussex; and though not so productive as the goldings, the Canterbury grape, or the Mayfield grape, are preferred by the farmers who grow them on account of their superior power of resisting the blight. A celebrated variety, called the Farnham hop, is cultivated in the vicinity of Farnham in Surrey, and in some other districts; and another variety, which possesses some celebrity for the delicacy of its flavour, is cultivated principally in the counties of Hereford and Worcester. A variety called the Flemish red-bine, is the coarsest of the cultivated kinds, and the nearest in habit and character to the wild plant; but it is also the hardiest, and is therefore the most suitable for trials on a limited scale, for occasional introduction to the fields or the garden plots of Scotland or the north of England, or even for stated cultivation in the bleak parts of the proper hop districts.

Properties of the Hop.—The stem of the hop-plant abounds in the same kind of fibre as hemp, flax, and other cordage plants; but requires to be steeped in water during a whole winter, before the fibre can be separated for the purposes of manufacture. The hop-plant contains a considerable quantity of tannin; and is capable of being used for the same purposes as oak bark, valonia, sumac, mimosa, and terra japonica. The dried strobiles, or flowers of the female plant,—which are always the main object, and often the only one, of the cultivation of the hop,—have a peculiar, strong, fragrant, semi-narcotic odour, and a highly aromatic, bitter, astringent taste.

A substance which constitutes only one-sixth part of the total weight of the dried strobiles, which is easily separable from the rest of the constituents by means of sifting through a fine sieve, and to which the name of lupulin has been given, contains the whole of their active properties, and though not a pure or proximate principle, but comprising a large admixture of principles, may be regarded as representing all their economical and medicinal value; and every 120 grains of this substance consist of 5 grains of tannin, 10 of extractive, 11 of bitter principle, 12 of wax, 36 of resin, and 46 of lignin. The ashes of dried hops amount to one-tenth of the whole weight, and consist of 21·5 per cent. of silica, 25·18 of potash, 15·98 of lime, 5·77 of magnesia, 7·24 of common salt, 7·45 of phosphate of iron and phosphate of alumina, 5·41 of sulphuric acid, 9·8 of phosphoric acid, 1·67 of chloride of potassium, and a trace of manganese.

An extract is yielded by the remains of the strobiles, after the separation of the lupulin; but it possesses neither the aroma, the bitterness, the astringency, nor any of the other active properties of the plant. An infusion or decoction of the strobiles in boiling water possesses all their active properties, has a pale straw colour, is made turbid by the action of a mineral acid, acquires a deepening of colour from an alkali, yields up ammonia to a certain compound reaction, and is precipitated by alcohol or by a solution of superacetate of lead. A volatile aromatic oil is obtained by distilling the strobiles in water.

Uses of the Hop.—In Sweden, a strong, durable, white cloth is manufactured out of the fibre of the hop; and in England, a patent was, a number of years ago, taken out to secure the benefits obtainable from the application of the root, stem, and leaf of the plant to the tanning of leather. But the grand economical use of hops, for many ages, has been the employing of the dried strobiles of the female hop in the brewing of ale, beer, and porter, for the double purpose of preserving the liquids from the acetous fermentation, and of imparting to them a bitter aromatic taste. Many other vegetable substances have been tried for correcting the insipid sweetness of malt liquors, and preserving them from spoiling,—particularly the tops of *Erica vulgaris*, twigs of *Buxus sempervirens*, dried leaves of *Menyanthes trifoliata*, leaves of *Glechoma hederacea*, and roots of *Gentiana acaulis*, *Gentiana rubra*, *Gentiana lutea*, and some other gentians; but though all these, as well as parts of some other plants, are more or less successful, the best are much excelled by the dried strobiles of the hop.

Dried hop strobiles—or hops, as they are usually termed—have been extolled from remote times, and in many writings, both popular and scientific, for their medicinal virtues; and they continue to the present day, to have a place in the pharmacopœias of both London and Edinburgh. Their general powers, when administered internally, are narcotic, tonic, and diuretic,—and, when applied externally, anodyne and discutient. Coles, in his History of Plants, published in 1657, says, "They are good, to cleanse the kidneys of gravel and to provoke urine; they likewise open obstructions of the liver and spleen, and cleanse the blood and loosen the belly; and, as they cleanse the blood, so consequently they help to cure eruptions of the skin." Brooke's Dispensatory, published in 1753, recommends them in a similar way to Coles, and also as an alterative, and as a remedy for hypochondriasis. Herophilus Labbius says that, by a persevering exhibition of hops, he has softened the hardest urinary calculi; and Darelius assures us that a pint or half a pint of a decoction of them, drunk in the morning, acts powerfully as an anthelmintic. Dr. Motherby, Dr. Cullen, and many other distinguished physicians have extolled hops as an elegant aromatic bitter. Numerous general and popular writers have asserted that hops, when used as stuffing for a pillow, possess the power of procuring sleep in cases of mania and in the delirium of fever; and this opinion was confirmed in the case of George the Third, and has to a certain extent been sanctioned by the observations of general practitioners. Some medical men, also, have extolled hops as a sure and steady sedative; while others accord to it very little of this character. A fomentation with hops has proved useful in painful swellings and tumours; and an ointment of powdered hops and lard is said to be serviceable as an anodyne in cancerous sores. The tender tops of hop-plants are cut off and eaten like asparagus in spring; and several syrups, juleps, and apozems are prepared from the strobiles; and all these are popularly regarded as good medicaments for various classes of invalids,—especially the hysterical, the hypochondriacal, and the dyspeptic.

History of the Hop.—The hop-plant grows wild in hedges, thickets, and similar situations in England, Sweden, Germany, and Switzerland; and probably was artificially diffused, at a remote period, through various other countries of Europe. It was supposed by Linnæus to have been brought to Europe by the Goths, during the periods of their immigration from Russia, and particularly from the Ukraine; but it has as good a claim as many a far more common plant to be regarded as truly indigenous.

Either the hop, or some very similar plant, which cannot now be distinguished from it, was known to the Romans, and probably to the Greeks. It is mentioned by the Arabian physician Mesue, who flourished about the middle of the 9th century; and it comes slowly and with increasing clearness into view as a cultivated European plant, from about the time of Charlemagne till a century after the Reformation. Pepin, the founder of the Carlovingian dynasty, speaks of *humulariæ*, or hop-gardens; and Adelard, bishop of Corbey, in 822, freed the millers of his district from all labours relating to hops. Some documents of the time of Louis the German mention hop-gardens; and the records of some churches and monasteries, in the two succeeding centuries, allude to hop-garden produce.

In the 14th century, hops were cultivated in many parts of Germany; about the same time, they were introduced to the breweries of the Netherlands; and in the third decad of the 16th century, they were introduced to public notice in England for the purposes of brewing, by some people from Artois. "But," says Beckmann, "although their efficacy was admitted in the conservation of beer, yet they were long supposed to contain qualities noxious to the constitution, among which it was said that they dried up the body, and increased melancholy; and accordingly we find in the household regulations of our Harry the Eighth, an order to the brewer, not to put any hops into the ale. Indeed, at a much later period, the Common Council of the city of London petitioned Parliament against the use of hops, 'in regard that they would spoil the taste of the drink, and endanger the people:' they were also petitioned against in the reign of Henry VI. 'as a wicked weed!' They were not brought into cultivation in this country until about the year 1524; and according to a distich to be found in Baker's Chronicles, it would seem as if the introduction of beer should be attributed to the same period.

> 'Turkies, carps, hoppes, piccarell, and beere,
> Came into Englande all in one yeare.'

This, however, must be understood of beer, such as that still in use; for ale brewed from malt, without the addition of hops, was certainly known here at a much earlier date."

In 1552, some privileges were granted, by act of Parliament, to hop-grounds; in 1578, a curious little work, containing directions for the cultivation of the hop, and called 'A Perfite Platforme of a Hoppe Garden,' was published by Reynold Scott; and in 1603, the introduction and use of damaged or adulterated hops are forbidden by statute under severe penalties. "In Sweden, the sweet gale, *Myrica gale*, was formerly used in beer so generally that Christopher III. in 1440, confirmed an old law, said to have been made by Magnus Smeek, that those who collected this plant before a certain period, on any common, or on another person's land, should pay a fine. The like punishment was appointed for the too early picking of hops; and the cultivation of them was so strongly enforced, that every farmer who had not forty poles with hops growing round them, was punished, unless he could show that his land was unfit for producing them. Gustavus I. of Sweden, also was desirous of encouraging the cultivation of the hop-plant; but his exertions were attended with so little effect, that even in the reign of Christina, that is, in the middle of the 17th century, all the hops used in the kingdom were imported from Germany, particularly from Brunswick and Saxony. The queen had some hop plantations as rarities in her garden; and the plant became soon so far generally cultivated, that the German hop farmers, who before had been accustomed to travel to Sweden every third year to receive payment, and take new orders, were much dissatisfied, and suffered a part of their hop-grounds to run to waste. Under Charles XI., who reigned from 1660 to 1697, the cultivation of hops was first brought to any degree of perfection."

British Soils for the Hop.—Scotland and the north of England are too cold for the profitable or even safe cultivation of any of the fine varieties of the hop-plant in the field. A few plants are occasionally grown in gardens; yet more for ornament or curiosity than for use. If ever a crop should be attempted in ordinary farm culture, the coarse and hardy Flemish red-bine ought to be selected in preference to any finer variety. Lord Kaimes recommends that hop-plants, grown in Scotland, should be trained low, upon espaliers or poles of 9 or 10 feet long, set upon a line from east to west, at intervals of 3 feet between each pole. He does not specify any particular distance between the rows; but probably a distance of 6 or 7 feet would be most suitable. He instructs that, in the making of the plantation, the planter should begin at the west end of each row, and set a plant at the foot of each pole, excepting the last 6 or 7 poles of the row; and, instead of allowing the growing plants to ascend the poles in the natural manner, he recommends that they be trained diagonally from pole to pole, at an angle of 9 or 10 degrees with the horizon, and that they be bound to the poles, and that their shoots be led, by means of small twigs, between the poles.

The chief parts of England in which hops are at present regularly cultivated as a field-crop, are large districts of Kent, Sussex, Hampshire, Hereford, and Worcester, and small parts of Essex, Hertford, Lincoln, Suffolk, and Derby. These districts present a surpassingly opulent appearance; and figure in marvellous contrast to the districts of mixed or pastoral husbandry in their near vicinity. "If a foreigner," remarks Mr. Lance, "were to land at the Isle of Thanet to view the agriculture of the south-east of England, and to take the following route, he would give a very different account from one who would pass through another part of the country. Of the first, we would take him from the Isle of Thanet up the Stowe river to Canterbury; following the course of that river, over the tenacious alluvial loams resting on the chalk formation, through the gorge of the chalk escarpment to Ashford, across the green-sand and Kent rockstone hills to Tenterden, Smarden, Cranbrook, Hawkhurst, and to Turnbridge, on the clayey and iron sand weald; viewing the ragstone hills to Maidstone, Malling, Wrotham, Sevenoaks, and Westerham; leaving the winding vale of Holmesdale to the north, being the site of the gault clay; thence passing into Surrey near Oxted to Riegate, Dorking, Guilford, and Farnham to Alton and Hampshire, thence to Petersfield and Portsmouth. This person would leave the country impressed with the idea, that every part abounded in hop and fruit enclosures. This traveller would call the country rich beyond any measure to be found on the Continent, having some land which would let for £20 per acre per annum, the valleys abounding in valuable timber, the inhabitants well employed, and enjoying the blessings of peace and plenty, in the midst of garden farms, and those exceeding in beauty and abundance the gay vineyards of the south. The other traveller we will suppose to land at Dover, passing over Barham chalk downs, and following the course of the north downs in Kent, a very few miles north of the line we have before traced; passing into Surrey on the chalk downs near Warlingham, taking the direction of the downs, and on to the Bagshot sand district near Woking; passing into Hampshire two miles north of Farnham, at Aldershot, to Basingstoke, over Salisbury Plain, and thence through the New-Forest to Lymington on the coast. This person would describe the aspect of the country as nearly a barren waste, fit only for rearing sheep on the chalk downs. The timber growing on it being that of a poor single mineral soil, the district thinly inhabited, the villages far distant from each other, would give to a stranger a very bad opinion of the riches of English agriculture, and the resources of the country. And these views would be the effect of a superficial examination of the south-eastern part of England, the party not taking into his estimation the geological arrangement of the earth."

Yet though certain adaptations of soil and situation are indispensable, the hop is cultivated and flourishes in a great variety of soil. The land of the hop-plantations throughout the greater part of East Kent has a deep, rich, loamy soil, and a loamy brick-earth subsoil, incumbent upon chalk; that around Maidstone, and thence to the stone-brash below the chalk hills on the borders of the wealds of Kent, is generally accompanied with marl; that of many parts in the vicinity of Farnham is either a very mellow hazel mould, or a dry, friable, very deep siliceous loam, incumbent on a marly or calcareous subsoil; and that of Hereford and Worcester is either of a red, sandy, ochreous nature, or clayey and binding, and is incumbent generally on a crumbling kind of shale and rag-stone, but never upon chalk. Any strong deep soil, on a free, porous subsoil, with a southerly or westerly exposure, and with good shelter by rising grounds or plantations from northerly and easterly winds, may, if properly trenched and pulverized, be found suitable, even in places far remote from the present hop districts; only it may require a special selection of the variety of hop best adapted to it, and might, very probably, modify the flavour or other properties of the produce. Mr. Lance, speaking with special reference to Kent, says, "The most congenial soil is a calcareous or loamy sand, with its stone-brash, as the roots are found to penetrate into the clefts of the latter to a considerable depth. The soil or stratum of earth where they flourish is termed by geologists the greensand formation, having some portion of friable green sandstone on the upper part. From this it passes downwards into a close calcareous marl, of various colours, from a bright red to a white siliceous sand. This hill of stone runs parallel with the escarpment of the chalk-bank, which it equals in height in many parts; and is distant from the chalk formation from a quarter of a mile to a mile, the intervening valley being a clay marl. A good hop is also grown in the sand or rich deep loam on the chalk formation, as at Canterbury. We may add, that, in every instance, a fresh, rich, dark, loamy soil, with a dry bottom, seems best adapted for the growth of the hop. On arable lands, it seldom succeeds."

Preparing the Ground for the Hop.—Any kind of land designed for the hop requires to be deeply tilled, completely cleaned, and powerfully manured. The hop-farmers of Hereford and Worcester generally select for an intended hop-plantation a piece of old pasture, and prepare it by giving a double ploughing, about a foot deep, in the early part of winter, and by thoroughly scuffling, harrowing, and rolling it about the beginning of March. But the hop-farmers of Kent, Surrey, and Sussex, for the most part, set to work upon ploughed ground, and treat it with a particularity and operoseness somewhat proportionate to the great importance of the hop. The ground is cleaned and pulverized with the processes of either a summer-fallow or a green-fallow; it is then manured with 25 or 30 loads per acre, or in some instances with even a larger quantity, of good farm-yard manure; it is next, in very many cases, sown with Norfolk turnips, and folded off with sheep in the early part of winter; and then, as quickly as it can be freed from the sheep, it is trenched with either the spade or the plough, and laid up into sharp ridges to undergo the chemical action of the air and frost and meteorological vicissitudes of winter. Trenching with the spade is done two spit deep, and is esteemed the more advantageous method of the two for thoroughly and equally intermixing the manure, for giving great and uniform porosity to the soil, and for facilitating at once the descent, the spread, and the maximum nutrition of the roots of the hop-plants; yet trenching with the plough is highly efficient, and at the same time is so much less expensive as to be generally thought the more economical method.

The prevailing practice is to propagate the hop from cuttings or young plants, or literally to make plantations; and this requires the ground to be disposed either in pits or in a series of limited spots for the reception of the plants. The method of planting in pits occasions considerable modification of the preparatory tillage, but is now almost universally abandoned. Farmers who plant in series of limited spots, or on little hillocks, differ widely in opinion, as to both the proper distance between the spots, and the most economical manner of arranging them. Some dispose them in parallel rows, 8 or 9 feet between row and row, and 3 or 3½ feet between hillock and hillock; others dispose them in triangular rows, or in a quincunx arrangement, at distances of 6 or 7 feet between hillock and hillock; many, throughout Kent, whether disposing them in parallel rows or arranging them in quincunxes, mark them out in such a manner, with a four-rod chain, as to assign 1,000 hillocks to the acre; and others, in even the best hop districts, and in near vicinity to one another, dispose them at distances of from 3 to 8 feet, or within areas of from 5 to 9 square yards. The common Kent and Sussex practice, whatever arrangement be preferred, is to use a measuring chain, with bits of rags in the links at the desired distances of the hillocks, and to mark off the first line of the plantation parallel to a fence, and at a few feet's distance from it. Any distance less than 6 feet in any direction is probably uneconomical; for though a considerably less distance might seem to be sufficient for the growth of the plants, and therefore an economizing of the soil, yet, when the plants become tall and soar away toward their maturity, it prevents them from enjoying a free circulation of the air, embarrasses their efforts to draw ample aeriform nourishment from the atmosphere, and subjects them to imminent risk of injury or destruction from blasts, aphides, moulds, and mildews. The main advantage of disposition in parallel rows, is the admitting of after-culture by means of horse-drawn implements; and the main advantage of disposition in quincunxes is the rendering the distances on all sides of each plant equal, and the consequent promotion of free and equable ventilation.

The Planting of the Hop.—Hop-plantations are made either with fresh cuttings from hop-plants, or from cuttings which have rooted in the manner of layers, or from cuttings which have rooted in a nursery-bed. When fresh cuttings are used, they ought to be taken from the crown of the root, and immediately planted; but even when they are of prime quality, of the best age, and in the most suitable condition, and when they are removed and planted with the utmost skill and care, they are usually a year longer in arriving at maturity and yielding produce than cuttings which have been rooted. Shoots treated in the manner of layers are simply twisted at the joint where they are intended to be put into the ground, and they are then bent into the soil, and fastened down with a peg, and freed, if necessary, from any superfluous top-growth; and when they have remained long enough in the ground to strike root, they may be dissevered from the parent stock, and allowed to remain in the soil till the time of planting. Cuttings treated as nurslings, are taken off in spring from the lower part of the stem or the root-crown of old plants, at the time of dressing; and are planted, in the ordinary manner, in a nursery-bed, and allowed to stand till they become well rooted. All cuttings ought to be at least 4 or 5 inches long, and to have each 3 or 4 buds; and any which are very luxuriant when taken up to be transplanted into the hop-ground, ought to be pruned in both top and roots.

Fresh cuttings must be planted in the hop-ground at some time between the end of February and the 25th of March; but rooted cuttings may be planted in either October, November, February, or March. "When the spots for the different hillocks have been marked out, the earth is dug out of each to the depth of about 2 feet, and of nearly the same width; and then, if a portion of fine garden mould can be got, or, if not, a compost of well rotted dung and earth, it is placed in the holes, which are filled up with the finely pulverized soil. The plants are then put in. Some put three or more in a circle, others two, and some only one good plant; but the most general plan is to place three in each hole, at the depth of about 6 inches; and great nicety should be observed in fixing them. The holes made by the dibble for that purpose are in a slanting direction outward, so that the roots of the hop may grow in the inclined position in which the poles are afterwards placed, without allowing their bines to be interlaced. Some careful growers, indeed, put the fine mould gently in, around and upon the plants, with the hand. The plants should also be raised above the natural level of the ground, both in order that the hop may rise high enough to form the hillock to be made around them, and that the root may have a greater depth of loose earth below them; for, when the land is very open, they penetrate so far into the soil that they have been found on a very rich deep loam in the neighbourhood of Farnham to the depth of 20 feet."—[British Husbandry.] But on the hop-farms of Hereford and Worcester, three sets are dibbled in at each site, and pressed up as tightly as possible with soil, and covered with about half an inch of light mould. On these farms, also, the marking out of the rows of sites is effected by setting up poles at the ends of the rows, extending a line from pole to pole along each intended row, and placing sticks at the proper intervals along the course of the line.

After-Culture of the Planted Hop.—The Kent and Sussex after-culture, during the first years, consists in a series of operations for keeping the soil clean, pulverulent, and well aerated. Horse-drawn implements are used between rows; and the hand-hoe and the spade in quincunxes. Weeds hoed up, are raked off the ground; and weeds dug up, are buried in the soil. The aeration and moisture of the fresh-turned soil greatly invigorate the young plants, so that skilful farmers often repeat the processes of stirring; and many also employ coarse woollen rags for the threefold purpose of keeping the soil open, attracting moisture, and slowly surrendering their substance in the way of manure. When the young shoots appear above the hillocks, small poles are stuck down beside them, of from 10 to 12 feet in length, or of any other proportion suited to the anticipated growth and luxuriancy of the plants; and when the plants attain a height of about two feet, they are separately tied or twisted round the poles; and early in November, all the ground in the intervals is dug over, and laid up toward the plants, and left in a rough state to enjoy the mellowing action of the frosts of winter. But in Hereford and Worcester, the first year's after-culture is somewhat different. About midsummer, the young stems are tied with rushes to the sticks, the adjacent soil is turned over against them with the plough, and the weeds are removed with a kind of spade, called a kuf, fixed almost horizontally upon a shaft of about 4 feet in length.

The after-culture of subsequent years varies according to the nature of the soil, the usages of different districts, the notions of the different cultivators, and the modifying effects of the different forms of the plantations. But plants raised from rooted cuttings bear produce in the second year; and the particular after-culture of that year, be the mode of it what it may, is very nearly the same as the after-culture of each succeeding year. Some farmers dig all the land in winter; some dig it all twice a-year; some plough the intervals, and dip the slips; and those of Hereford and Worcester plough down the soil from the roots. All, however, use care to disturb as little as possible, or not to disturb at all, the roots of the young plants; and all are likewise agreed, if not as to the precise form, at least as to the principle, of all the leading operations. In February or March, the hillocks are cleared of weeds, and carefully opened, either with a narrow-pointed hop-hoe, or with a double-faced implement, forked on one face, and containing a strong hoe on the other; the old bine or lower part of the last year's shoots, together with the lower part of all suckers, is cut away, with a sharp pruning-knife, to within an inch or two inches of the main stem; and the fine soil is sufficiently replaced to form anew the hillocks, and to prevent the air from having free access to the pruned plants,—yet only about 1½ inch of the richest and finest of it is placed immediately over the crown of the roots. The Hereford and Worcester farmers, however, prune the plants at the time of ploughing down the soil from the roots, and then throw a little loose soil over the root-crowns. In April, when the new shoots are sufficiently up, two, three, or four poles, but generally three, are set to each hillock, the poles varying in height from 12 to 18 feet, according to the judgment of the cultivator, or the anticipated wants of the crop; and in May, or as soon as the shoots are sufficiently high, they are tied, two or three to each pole, with soft rushes. Throughout all the season, or at least till the fibres of the roots spread themselves so near the surface as to forbid the removal or stirring of the soil to a hoeing-depth, the same frequency of cleaning and stirring, and the same busy promotion of pulverulence and aeration, must be practised as during the first summer. Early in June or about midsummer, all bines which were left loose at the time of tieing the shoots to the poles are cut away; after this, each hillock is completely dug or pronged up, and a little mould is drawn up to the crown of it with the hoe, or some portions of the soil are removed, and the cavity filled up with fine manure or rich compost; and a few weeks later, this process, with the exception of no manure or compost being in the alternative, is repeated. The Farnham hop-farmers also 'pear' or hoe the ground if any weeds should appear between these two operations, and likewise immediately before the picking of the hops.

In the spring of the third year, and afterwards of every alternate year, or at furthest of every third year, farm-yard manure is applied to the hillocks at the rate of from 20 to 25 loads per acre. It is usually carted out during the frosts of winter; it is frequently made into a compost with equal or greater quantities of soil; and, at the time of opening the hillocks and pruning away the old bine, it is applied to the soil of the hillocks, and thoroughly intermixed by means of a three-pronged fork. On hop-plantations near the sea, sprats and star-fish are frequently used for manure; and on all plantations which have soils of clay, strong loam, or any other kind of cohesive substance, at once the strongest, the most durable, the most aerating, and in all respects the most suitable manure, wherever it can be obtained in sufficient quantity, and upon economical terms, is woollen rags. But an excellent manure, a decidedly efficient one, and the cheapest and most obvious of all, though hitherto almost universally neglected, consists of the chopped hop-bine itself, either dug into the ground fresh in November, or laid up in heaps to decompose into a rich, black, oily, compost-looking substance, and to be applied at the usual time in spring. Some recent experiments have shown highly in favour of hop-bine manure; and the mere principles of agricultural chemistry, quite independently of any appeal to experiment, are sufficient to declare its value. Excepting the comparatively small nitrogenous and mineral contents of the seeds and strobiles, the bine contains everything which the plant abstracted from the soil; so that the returning of the bine to the soil in the way of manure, accompanied with merely such a quantity of farm-yard dung, or hog's dung, or woollen rags, or refuse of fisheries, as shall compensate for the abstracted portion of the seeds and strobiles, restores the land to the same condition as before the crop was grown. When the seeds are generally produced, as in Mr. Lance's method, a considerable accompaniment of other manure will be requisite; but in other cases very little will be sufficient.

The Poling of the Hop.—The prevailing number of poles in the acre, throughout a great part of the Kent and Sussex hop-grounds, varies from 2,400 to 3,000; and, of course, it is mainly controlled by the distances of the hillocks, and by the amount of poling to each hillock. A common practice is to distribute the poles into three classes, of respectively about 10 or 12 feet, about 14 or 15 feet, and about 16 or 18 feet in length, in adaptation to the age, luxuriance, or anticipated tallness of the plants; and this practice involves both a great economizing in the cost of the poles, and a great protection of the strength of the plants. The expense of poles is a very heavy item in the costs of cultivation; and poles of 16 or 18 feet in length usually cost about three times as much as poles of 10 or 12 feet in length. The use of poles proportionately longer than the natural tallness of a plant, whether in the first year or in subsequent years, coaxes it unduly upward, stimulates it to an excited exercise of its powers, and occasions, in the following year, an impoverishment of its roots and a corresponding enfeeblement of its whole structure; while the accidental or mistaken use of too short poles, or an extraordinary and unanticipated luxuriance of the plants, can, in the course of the summer, be remedied by setting up such supplemental poles as shall maintain the shoots in a sufficiently erect and elevated position.

The poles are usually so adjusted as to incline somewhat outwards; for they at once give more room, occasion more aeration, secure a greater breadth of sunshine, and produce a larger yield of hops, in that position, than when placed upright. Two or three stems are usually tied and trained to each pole; and such stems are selected as, at the time of tieing, give the greatest promise of being vigorous and luxuriant. The tieing must take place at the critical moment when the stems are just long enough to admit of being bound to the poles without being much slanted from the roots, and before they have acquired a decumbent habit of lying attached to the ground. A process of a very questionable kind, called branching, is performed by some cultivators about midsummer, and by others after the hop-blossoms are set; this consists in removing all the leaves and side-bines over a space of two or three feet from the ground; and it is designed to aid some of the main purposes of poling, or to produce aeration, and send up a maximum flow of sap to the upper branches and floriferous parts of the plants. But it really maims the plants, disturbs their functions, and lessens their productiveness; and the design of it would be really accomplished by simply thinning out plants whenever they are too crowded, and leaving the rest to be aired and stimulated entirely by the poles. "Perhaps," says Malcolm, "when from the strength of the plant, and the closeness of the rows, the lateral branches occupy the great part of the intervals, it may be proper to shorten some of the most luxuriant; but I am not clear—particularly as it respects the hop, which is one of the most tender and delicate plants that are grown—whether it would not be more advisable to destroy every other plant in the row, or even every other row in the plantation, and by that means to procure the wished-for air, rather than, by shortening the shoots and taking off the leaves, run the risk of a very hot season, or an occasional cold and drying one,—thus injuring the plants, and giving perhaps a sudden check to the blossom before it is out of all danger."

A method of espalier training has been recommended, and in some instances practised, for the double purpose of economizing the cost of poles, and affording greater security to the plants from the effects of high winds. Rows of stakes or short poles, five feet high, and three feet apart, are fastened in the ground; and two transverse lines of paling-wood or cleft halvelings are adjusted, respectively along their top and along their middle, for the twofold purpose of keeping them steady, and of affording scope for the horizontal training of the plants. Hops grown in the usual vertically twining manner on tall poles, are sometimes bruised by high winds, and soon acquire a brown colour; and, when subjected to the process of drying, are bleached with the vapours of brimstone, or sulphurous acid, in order that they may regain the delicate yellow tint which is so generally admired in the sample. The espalier or paling mode of training prevents this disaster, and also gives the plants an ample exposure to air and sunshine, and obviates the crowding which is occasioned by the vertical method, and evolves an equal amount and superior quality of produce from a smaller number of plants. An important addition to the espalier method, specially adapted to the raising of the plants from seeds, but adapted also to the raising of them from either plain or rooted cuttings, is the placing of upright poles at regular intervals in juxtaposition with the espaliers, for the training of male plants, in order that the pollen of the male flowers growing high on these poles may fall right down on the flowers of the female plants upon the espaliers; and while the espaliers are fixtures, the upright poles may be removed yearly in the usual way. The training and tieing of the bine upon the espaliers must be progressive and continuous, as fast as the bine grows, till the plants come into bloom; and then it ought to cease.

Any kind of wood which possesses sufficient straightness and slenderness is suitable for ordinary upright poles. Beech and birch are very bad; and acacia-tree, oak, ash, willow, maple, and chestnut are good. Oak is most commonly employed in Lower Kent and the midland counties; and when the poles of it decay at bottom, or become too short, they are sold in the neighbouring towns for fuel. Ash, chestnut, maple, and willow, are very commonly used in other parts of Kent. The acacia-tree is probably by far the best, for intrinsic adaptation, for rapid growth, for durability, and for aggregate economy. See the article Acacia-Tree. The lower end of the poles is sharpened with an edge-tool, and, in some instances, somewhat charred by holding it over the smoke of a strong fire. The stripping of the bark is practised by many cultivators, and is thought by them to make the poles more durable, and especially to preserve them from the worm; but it possibly has no good effect whatever, and it deprives the poles of their proper warmth and softness, which are probably congenial to the hop-plants.

M. Denis, in his treatise on the cultivation of the hop-plant, recommends the substitution of trellises of iron-wires for the common system of vertical poles. The wires, according to his method, are formed into pieces of about a yard in length, and joined together so as to resemble a surveyor's chain, and suspended horizontally between posts of oak at the extremities of the rows of plants, and supported at regular intervals by wooden props; and the hop-plants are planted at distances from one another of 8 feet, and each left with four shoots; and the shoots are conducted up little iron rods to the wire-chain, and two of them trained along it in one direction, and the other two in the opposite direction. M. Denis—referring, of course, to the prices of materials in France, and especially in the Vosges—computes that, by this method, about a fifth part of the original cost of poles is saved, and afterwards 50 francs per annum for every 500 square mètres.

The Propagation of the Hop from Seed.—The hop-plants raised in the usual manner from cuttings, no matter to which variety of the species they belong, have a tendency, after a considerable course of cultivation, to become dwarfish, to lose their fine colour, to deteriorate in flavour, and even to dwindle into constitutional feebleness and eventually die out. The occasional raising of the plants from seeds, therefore, would seem to be necessary, not only for producing new varieties, but also for maintaining the vigour of the old ones; and even stated propagation from seeds, in total substitution of the common method of making plantations from cuttings, possesses eminent advantages as to both the aggregate economy of cultivation and the superior quality of the produce; and when this method is accompanied by the retaining of a due proportion of the male plants, and by such a distribution and training of them as to render all or nearly all the female plants seed-bearing, it is strictly natural, and brings into harmonious play all the constitutional energies of the plants, and can scarcely fail both to raise better plants and to educe a better produce than the usual, divorcing, and excessively artificial method.

Mr. Lance of Lewisham, a number of years ago, put the system of cultivation from seed, with intermixture of male plants, very successfully to the test, and published the results of his experiments in a tract entitled 'The Golden Farmer;' and both his practice and his principles have been approvingly quoted in various important agricultural works, particularly Baxter's Library of Agricultural and Horticultural Knowledge, the Quarterly Journal of Agriculture, and the Farmer's Series in the Library of Useful Knowledge. A specimen of Mr. Lance's hops, grown from seed, was exhibited at the Malling Agricultural meeting, and was allowed by the judges to be the most pungent and aromatic in the booth; and though not of so delicate a hue as some others, it was considered to excel them all in strength for the purposes of the brewer. In a comparative trial, the hops, without seeds, from Mr. Jorden's at Oxford, where the male plants had always been eradicated, weighed at the rate of 22 lbs. per bushel; the hop-seeds, without the leaves, from Mr. Love's at Shoreham, raised from cuttings, and grown near male plants, weighed at the rate of 35 lbs. per bushel; and the hop-seeds, without the leaves, from Mr. Lance's at Lewisham, raised from seed, with interspersion of male plants, and as gathered in the fourth year after sowing, weighed at the rate of 36 lbs. per bushel.

The seeds sown at Lewisham, we are told, were 'the goldings,' selected from plants grown in a hedge, where there was a male plant; and the plants came true to the original, but were of a superior size. "The male hop," says Mr. Lance, "has its flower or pollen previously perfected, so as to impregnate the stigma or burr of the female as soon as it is ready; which inoculation gives that energy and vitality to the seed, without which it would not produce its kind. It is the pollen which gives great weight to the hop, and also gives the fine aromatic bitter to the production of the bine, and more particularly so to its seed. The petal or leaf of the hop, contains but little of the astringent quality required, compared with what is found in the seed. The same atmosphere which ripens and wafts the pollen from the male, prepares the female for its reception. The experiments at Lewisham fully prove the beneficial effects of raising the plant from seed, and completing its fructification. The hop-plants raised from seed surpass those which have been raised from cuttings; their luxuriant growth enables them to withstand the effects of blight. The hops are found to have a seed at the bottom of every petal of the flower, of a most pungent aromatic flavour. Those hops, grown in the usual way, without the necessary quantity of male plants, have scarcely any seeds, and these are mostly abortive. We therefore say, that seed gives weight and flavour to the hop; it is the vitality of the plant. The grand object in hop-growing, therefore, should be to get as much seed as possible; and seeing that the plant cannot be completed without the male bloom, is it not most incongruous, that the hop planters will shut their ears against the voice of reason and nature, and care nought about the male plant? They grub them up wherever they find them as useless lumber, and say, 'Our fathers got money without male hops, and so can we; for why should we pretend to be wiser than our forefathers?' In saving the seeds, care should be taken, that they are selected from hops that have been properly impregnated by male farina, taken from the bine near a male hop. The seed from about the kiln, at the sweeping, may grow, but there is a great probability it will not, the vegetable life having been injured in drying. The seed should be sown early in the spring, in a mixed soil of chalk, clay, and sand; the latter earth should predominate. These may be set out in rows at the latter end of the year, where they should remain until the sexual distinction can be ascertained; this may be done by observing the leaf, and the forwardness of the plant. The next year, the males will show a rough leaf, when the females are only just breaking out of the ground. When the sexual distinction is known at the latter end of the second year, they may be planted into the ground where they are to remain, and may be poled the third year. If the soil is congenial, and the season not unpropitious, they will bear hops the third year. Every fifty female plants should have a male; and there will not be any objection to a male plant being in the same hill with the females."

The Picking of Hops.—The hop-plant begins to show the seed-vessel, or "to bell," some time in August; and it usually matures its strobiles during the first half of September. The picking of the hops takes place when the strobiles are ripe; but is regulated, in comparative earliness or lateness, by reference to the desired delicacy of colour or desired strength of aroma in the hops. When the scales begin to exchange a pale straw-colour for a light brown, to emit a fragrant and aromatic odour, to possess some firmness under the touch, and to be capable of being easily rubbed to pieces, they are, in a general sense, perfectly mature and quite ready to be picked. But such as are required to possess the utmost delicacy of colour, to need no bleaching influence from sulphurous acid, and to make the finest appearance to the eye in a market sample, must be picked before the seed is complete, and before the strobile can be soiled by the poles or bruised by the wind; while such as are required to possess the utmost strength of aroma for the practical uses of the brewer, ought not to be picked till the seeds are quite mature, and have acquired their utmost possible weight. At the period of ripening, a yellow juice, called by cultivators "the condition of the hop," is formed at the bottom of the scales; this is a constitutional provision for the nourishing of the seed, and seems to act the same part in hop-strobiles which nectar does in the flowers of melliferous plants; and, though always most abundant in such hop-plants as are most seminiferous, it appears even in those which have never been impregnated by pollen. Now when fine colour is required in hops, they ought to be picked the instant this juice begins to appear at the bottom of the scales; and when the utmost strength and weight are required, they ought not to be picked till the scales are in full condition, and have become brown.

But the hops of a plantation do not all ripen at the same time; and even those on one stem are not all of one quality. The Farnham growers, therefore, pick their hops in a series of gatherings, and so distribute them into classes as to have at least three different kinds, of different quality and price for the market. "They begin," says Stevenson, "at the bottom of the pole, and pick the hops one by one, without bunches, long-tails, or leaves. Those that are just of the proper degree of ripeness, and are full and fair in their appearance, are first gathered, and put by themselves into the bin-cloth; and such as are rather inferior in quality, or not exactly taken at the proper degree of ripeness, are of the second sort, and are likewise put by themselves in a basket. As, however, with the Farnham planters, hops that are under-ripe are more esteemed than such as are over-ripe, the second sort takes in only the greenish hops. Such as are brown and over-ripe are the third sort; and if the grower is very nice, a fourth basket is set for such as are defective in their form, or have received a check during their growth."

The "bin" or "crib" is a strong wooden frame, about 9 feet long and 4 feet wide, mounted upon legs a yard high, and placed in a convenient part of the plantation for receiving the hops from the pickers, and provided in the interior with a coarse cloth, which is hooked to its sides, and hangs within it like a large bag. As many bins are set up as may be needed for the gathering; and a corps of pickers, 6 or 8 in number, together with a man for collecting the poles, are appointed to each bin. The pickers of a plantation include, not only the stated labourers of the farm, but a multitude of men, women, and children from a distance,—many of whom bivouac from night to night in the field, during the hop-harvest, in precisely the same manner as gipsies. The hop-bine is cut asunder about 2 or 3 feet from the ground; the pole, laden with its bine, is wrenched out of the ground by means of a peculiar lever, technically called in Kent a hop-dog; and two poles are laid upon a bin, and committed to a set of pickers, 3 or 4 on each side of the bin,—or sometimes a single pole is laid upon a smaller bin or basket, and committed to the picking of one woman and her children. A copious bleeding of sap occurs from the dissevernment of the bine; so that the cutting of it nearer the ground than 2 or 3 feet would most probably enfeeble the root. Hops exposed to hot sunshine between the dissevernment and the picking, are liable to shrivel and discolour,—so that, in clear hot weather, only as many plants are taken up at a time as can be speedily picked; and hops picked in a damp state are liable to become musty,—so that plants taken up in a dewy morning are shaken hither and thither upon the poles, in order that they may be freed as much as possible from the dew.

The Drying of Hops.—Hops are dried in a structure very similar to a malt-kiln, and designated an oast; and the operation of drying is frequently called oastage. A small substantially built oast, with a proportionate store, costs from £200 to £300; but many an oast is much more expensive. An oast of 14 feet, when worked during the whole 24 hours, so as to perform two dryings or sets of drying within that period, is sufficient for 200 bushels of freshly picked hops, or 350 lbs. of dried hops per day. Some oasts have only single floors, and possess only one set of adaptations; but others have double floors, the upper five or six feet above the lower,—the former for the slow and cautious drying of very moist hops, and the latter either for the thorough drying of transfers from the upper floor, or for the immediate drying of hops which arrive somewhat dry from the field. The ordinary time requisite for drying a set in the single-floored oasts, or on the lower floor of the double-floored oasts, is about 10 or 12 hours; and the fuel employed must not injure the delicate smell and odour of the hops, and commonly is either coke or charcoal.

The operation of drying is a very nice one, and requires to be performed with great skill and care. The picked hops must not remain long in the bins or baskets, else they will heat and spoil; and therefore those picked in the morning are taken to the oast at mid-day. The temperature of the oast is previously raised to a proper height; the hops are spread out in a layer of greater or lesser thickness according to their degree of moisture; the temperature is maintained at a steady and moderate height till the effects of it begin to reach the upper part of the layer; it is then somewhat lowered, all the layer is turned upside down, and the temperature is raised to its former height, and is maintained there till the drying is completed. In proportion to the moistness of the hops, must be both the thinness of the layer and the moderateness of the temperature; for either a thick layer of moist hops with a low heat, or a thin layer with a high one, throws off volumes of steam, and is liable to be amassed into cakes and lumps. The hops, when fully dried, are shovelled into the adjacent store to be bagged for market.

The bleaching process with sulphurous acid is performed simultaneously with the drying; and is usually accomplished by the simple means of burning a little brimstone. A statute of 7 George II., confirmed by one of 35 George III., declares "that if any person shall mix with hops any drug or ingredient, to alter the scent or colour, he shall forfeit £5 per cwt.;" and this statute was judicially pronounced by Lord Kenyon to apply to the practice of bleaching with sulphurous acid. The practice, nevertheless, is done in the face of day, and beneath the nose of the minions of the law; and is almost as general throughout most of Kent and Sussex as the very process of drying. The Farnham hop-farmers, indeed, as well as some others of high character, never let sulphurous acid near their prime hops, and unquestionably owe a large portion of their deservedly high reputation to the keeping of these hops free from this drug; but the great body of hop-growers make no scruple of sulphur-bleaching the best hops as well as the worst; and some even appear to think that this abominable and mischievous process is essential to the development or the refining of the hops' aromatic odour.

Mr. Lance tersely and pithily remarks—though not without error in his chemistry—"The Farnham hops are found to keep their strength much longer than the Kent, because they have not any brimstone in them. In Kent, the most delicate-coloured hops are likely to be the most inferior in strength. The oil and flavour of hops are exceedingly volatile; the atmospheric air will take them away in a short time, and more particularly when sulphur is incorporated with them. In drying them with sulphur much of the aromatic bitter passes off with the fumes of the sulphur. The fragrant smell of the Kent hop, when it first arrives at the hop-market, may be considered as the strength and flavour passing rapidly away, assisted by the volatility of the sulphur with which it is impregnated."

The action of the sulphurous acid on the colour of the hops is a true bleaching, precisely the same as in its action on straw in the manufacture of bonnets, and very similar to the general bleaching action of chlorine. But its action on the taste and flavour of the hops is, not, as Mr. Lance supposes, to make an impregnation with sulphur, but to effect a change of chemical constitution. The purely fragrant principle of hops is, of course, a volatile oil, and suffers injury principally by being dissipated; but the purely bitter principle, or combination of bitter and aromatic principles, which constitutes all the real power of the hops, to prevent the acetous fermentation in malt liquors, is probably of an alkaline nature, like the quinina and cinchonina of Peruvian bark, the morphia of opium, the strychnia of nux vomica, the veratria of white hellebore, the picrotoxine of cocculus indicus, the solania of woody nightshade, the delphia of stavesacre, the sanguinaria of blood-root, and many other recently discovered alkaloids; and this principle, when subjected to the action of sulphurous acid, must undergo a total change of nature, and probably a deprivation of most of its peculiar power, by the destruction of its alkalinity. See the articles Alkalies, Alkaloids, and Acids.

The Bagging of Hops.—Hops, after being dried, must lie several days in heaps on the floor of the store-house, in order that they may acquire a sufficient degree of moisture to become somewhat tough and yielding; for when newly removed from the oast, they are exceedingly brittle; and, if not allowed to lie till they slightly moisten, they would break to pieces and almost fall into powder in the process of handling and packing.

The usual packages for hops are bags, containing from 1¼ to 1½ cwt., called pockets, and used only for the finest qualities, and sacks, containing 2½ cwt., called bags, and used for all the inferior kinds. A pocket, irrespective of its contents, weighs only 5 or 6 lbs., while a bag weighs 25 lbs.; and the latter is about 7½ feet in length and 8 feet in girth. The grand object in packing is to press the hops so firmly together as to prevent the dissipation of their fragrance and the decomposition of their substance by the permeation of the air. Now "to accomplish this in the most effectual manner," remarks Mr. Lance, "nothing can be better than a Bramah's hydraulic press, and the hops packed up in square bales of cloth, of various weights, for the convenience of families; and they would be stored in a warehouse much more conveniently in square packages than in round ones."

The ordinary method of bagging is described by the author of "British Husbandry" as follows:—"A circular hole, covered by a trap door, and sufficiently large to admit the mouth of a hop-bag, is made in the floor of the stowage-room. A few hops are tied tight in the lower corners of the bag, in order that, when full, they may be lifted and removed with ease. A hoop, rather larger than the circumference of the hole, is used to stretch out the bag, by means of hooks on the outer side of it, the inner side of the hoop, when the bag is let down into the hole, either resting on the floor or on a frame of wood made over it. When the bag is thus stretched out, and let into the opening, the feeder throws down a few shovelfuls; and 'the bagster,' descending into the bag, with flat shoes or leather socks on his feet, treads the hops regularly and carefully down, especially towards the sides. More hops are then thrown down, and closely pressed, until the bag is filled,—the tighter and closer the better, for the firmer they are packed the longer will they keep. The hoop is then loosened, the bag is let down to the lower floor, more hops are tied into the upper corners, and it is sewed up as closely as possible, the whole operation being generally completed within an hour."

The Expenses and Produce of Hop-Cultivation.—The expenses of cultivating hops consist of rent, tithe, taxes, interest of capital, culture-labour, repair of poles, manure, picking, drying, bags, bagging, and duty. Rent is very variable; manure is very variable; poles are exceedingly variable; and even culture-labour, picking, and drying are by no means uniform. Rent is controlled partly by situation, and mainly by the quality of the land; manure and culture-labour, by the situation; and fuel and poles, by nearness or remoteness of carriage. The total expenses up to picking are usually estimated at an average of about £30 per acre, but are highest in Middle Kent, and lowest in Hereford and Worcester; and the total expenses from picking onward, including drying, bagging, carriage, and factorage, vary from about £36 to near £49. Yet an estimate before us of the expenses of cultivating 4 acres in Middle Kent in 1836, exhibits a total, for the 4 acres, of only £149 10s. 6d., or per acre scarcely £37. The items are these: Rent and taxes on 4 acres at 40s., £8; culture-labour at 50s., £10; repair of poles, £4; manure at 40s., £8; picking 4,332 bushels at 7 for 1s., £23 15s.; pole-pulling, measuring, and attendant expenses, £4 16s.; the labour of drying, £3 12s.; charcoal, £6 10s. 6d.; sulphur and lime, 17s. 6d.; rent of oast, £4; cloth for pockets, £4; making and bagging 39 pockets at 1s. 2d., £2 5s. 6d.; interest on the year's expenditure, £4; duty on 64 cwts. at 18s. 8d., £59 14s.; tithe, £4; total, £147 10s. 6d. Mr. Lance calculates the subsequent expenses of each cwt. of hops purchased on the poles as follows:—The duty, 18s. 8d.; picking, 10s.; bags, 1s. 4d.; drying, 5s.; bagging, 9d.; cartage, 2s.; sale, 1s.; total, £1 18s. 9d.

The produce of hops varies, not only with soil, season, culture, and most other circumstances which affect the great majority of field crops, but with some mightily controlling influences in the form of casualties and diseases; and, within almost any short cycle of years, it may take the enormous range per acre of from 1 cwt. to 20 cwts. Cultivators regard about 7 cwt. per acre as both an average and a remunerating produce; and however paradoxical the statement may appear, they are almost as much afraid of a very large produce as of a very small one. A minimum produce, of course, is great and dead loss; but a maximum produce so deteriorates prices, and entails such a heavy amount of inferior and almost unsaleable stock, and at the same time is so totally unaccompanied with any diminution in the costs of picking, drying, bagging, and duty, as sometimes to prove excessively embarrassing. So exceedingly heavy are the expenses of cultivation in all years, that only men of large capital can be hop-farmers; and so prodigiously uncertain and fluctuating is the produce, that only men of much enterprise, who prefer the excitement of speculation to the calm pursuits of measured industry, can continue, for any length of time, to be hop-growers. "Although the culture of hops," remarks a writer already quoted, "may in a course of years prove lucrative, yet the great uncertainty of its return renders it so speculative as to partake more of the nature of gambling than of the regular operations of husbandry. This, however, seems to be the great inducement for its continuance; for although heavy losses are frequently sustained, yet as brilliant prizes are also sometimes gained, there are always people to take their chance of such a lottery."

A table of the average produce of hops from 1807 to 1836, given in Mr. Lance's work, shows a lower result than our statement,—exhibiting the minimum at 0·97 of a cwt., the maximum at 12·2 cwts., and the grand average at very nearly 5½ cwts. The average in 1807, according to this table, was 4·88 cwts.; in 1808, 12·2 cwts.; in 1809, 3·1 cwts.; in 1810, 3·53 cwts.; in 1811, 7·62 cwts.; in 1812, 1·47 cwt.; in 1813, 6·2 cwts.; in 1814, 4·44 cwts.; in 1815, 5·47 cwts.; in 1816, 1·95 cwt.; in 1817, 2·68 cwts.; in 1818, 7·65 cwts.; in 1819, 8·64 cwts.; in 1820, 5·14 cwts.; in 1821, 6·31 cwts.; in 1822, 8·71 cwts.; in 1823, 1·17 cwt.; in 1824, 6·38 cwts.; in 1825, 0.97 cwt.; in 1826, 9·94 cwts.; in 1827, 5·3 cwts.; in 1828, 6·62 cwts.; in 1829, 1·55 cwt.; in 1830, 3·51 cwts.; in 1831, 6·91 cwts.; in 1832, 5·49 cwts.; in 1833, 5·94 cwts.; in 1834, 6·89 cwts.; in 1835, 8·14 cwts.; and in 1836, 6·74 cwts. When these 30 years are divided into three cycles of each 7 years, and a fourth cycle of 9 years, the cycles exhibit a remarkable similarity to one another in their respective averages; the cycle of 1807—1813 showing an average of 5·58 cwts., the cycle of 1814—1820 an average of 5·48 cwts., the cycle of 1821—1827 an average of 5·62 cwts., and the cycle of 1828—1836 an average of 5·31 cwts.

Enormous as is the range in the diversity of produce, it has a considerable counterpart both in the range of the market-value per cwt., and in the range of the total value of the country's produce. During the period from 1820 till 1839, the market-price per cwt. ranged from £3 3s. to £23, and the estimated value of the total yearly produce of the country, inclusive of the duty, ranged from £446,038 to £3,155,832; and the total value in the year of lowest price per cwt. was £1,241,252, the total value in the year of highest price per cwt. was £805,874, the price per cwt. in the year of lowest total value was £10, and the price per cwt. in the year of highest total value was £8 10s. In 1820, the estimated number of acres in cultivation was 50,148, the average price per cwt. £3 17s., and the total estimated value, £753,110; in 1821, the acres 45,662, the price £4 4s., and the total value £1,000,000; in 1822, the acres 43,554, the price £3 12s., and the total value £1,221,985; in 1823, the acres 41,458, the price £10, and the total value £446,038; in 1824, the acres 43,449, the price £7, and the total value £1,847,960; in 1825, the acres 46,718, the price £23, and the total value £805,874; in 1826, the acres 50,471, the price £4 4s., and the total value £2,010,590; in 1827, the acres 49,485, the price £4 12s., and the total value £1,360,835; in 1828, the acres 48,365, the price £5 5s., and the total value £1,813,680; in 1829, the acres 46,135, the price £9, and the total value £656,125; in 1830, the acres 46,726, the price £10 10s., and the total value £1,509,560; in 1831, the acres 47,129, the price £5 15s., and the total value £1,767,324; in 1832, the acres 47,101, the price £9, and the total value £2,114,545; in 1833, the acres 49,187, the price £6, and the total value, £1,841,610; in 1834, the acres 51,273, the price £5 10s., and the total value £1,974,010; in 1835, the acres 53,816, the price £5, and the total value £2,406,640; in 1836, the acres 55,422, the price £8 10s., and the total value £3,155,832; in 1837, the acres 56,323, the price £4 10s., and the total value £1,647,396; in 1838, the acres 56,104, the price £5, and the total value £1,753,120; and in 1839, the acres 52,365, the price £3 3s., and the total value £1,241,252.

The Duty on Hops.—The original duty on hops was 1d. per lb. or 9s. 4d. per cwt.; afterwards, by an addition of 3 per cent., it became within a small fraction of 10s. 9d. per cwt.; in 1802, a new duty was imposed of a small fraction above 12s. 7d. per cwt., making the total duty £1 3s. 4d. per cwt.; and in 1805, a reduction was made of ½ per lb. or 4s. 8d. per cwt.; rendering the total duty 18s. 8d. per cwt. The duty remained at this last rate till the 3d year of Victoria, when an addition of 5 per cent. was imposed.

A duty on malt can be vindicated on the principle of the article being manufactured; but a duty on hops is a direct tax upon the produce of the land, and seems to involve a rule which might, with equal force, apply to all field and garden crops which partake, in any degree, of the character of either luxury or medicine. But the mode of levying the duty, when viewed, as it must be, in connexion with the singular precariousness of the crop, renders the impost exceedingly inexpedient, and is indirectly productive of enormous evil. "Whatever benefit," remarks Mr. Henry Stephens, "is derived from this impost to the revenue, from which nearly £4,000 a-year must be deducted for its collection, is more than counterbalanced by the spirit of gambling engendered in speculators, who make purchases solely in accordance with the probable amount of duty to be exacted. Offers made to farmers, resting on this contingency, lure them also into that vice, and frequently make them suffer; and they cannot avoid the temptation, for the casualties affecting hops are so uncertain, that the prospects of a crop may be blighted or secured in the course of a few days. Thus, in 1834, the hop was so much affected by the aphis, that the whole amount of duty was struck at about £100,000 over all the districts; but on thunder showers falling and destroying the insect just in time, and the weather after proving very favourable to the growth of the plant, actually raised the duty, which was paid, to £329,936, thus indicating an increase in the value of the apprehended crop of more than 3 times. Were there no duty, the farmer would dispose of his hops, when he realized them, as he does any other crop."

The total duty, both new and old, in 1820 was £240,574; in 1821, £268,886; in 1822, £354,203; in 1823, £45,317; in 1824, £258,838; in 1825, £42,290; in 1826, £468,410; in 1827, £244,953; in 1828, £299,178; in 1829, £66,780; in 1830, £153,125; in 1831, £304,112; in 1832, £241,770; in 1833, £272,878; in 1834, £329,936; in 1835, £409,055; in 1836, £348,404; in 1837, £310,570; in 1838, £298,359; in 1839, £357,456; and in 1840, £266,898. The amount of old duty, in 1844, was £140,322 17s. 2¾d.; the amount of new duty, £103,716 17s. 11¼d.; the amount of the additional duty of 5 per cent. imposed in the 3d year of Victoria, £12,201 0s. 0¾d.; the grand total of duty in 1844, £256,240 15s. 2¾d. The proportions in which this grand total were levied from the several districts, together with the number of acres then under hops in each district, were as follow:—Barnstaple, 5¾ acres, £17 7s. 3¾d.; Cambridge, 8 acres, £26 14s. 11½d.; Canterbury, 9,001¼ acres, £38,637 15s. 6d.; Cornwall, 2⅒ acres, £2 16s. 1¼d.; Derby, 86 acres, £273 0s. 2⅛d.; Dorset, 12 acres, £24 7s. 10¾d.; Essex, 201 acres, £821 7s. 5½d.; Gloucester, 10⅛ acres, £12 1s. 7¼d.; Grantham, 27¾ acres, £40 3s. 11d.; Hants, 1,551¾ acres, £11,083 8s. 11¼d.; Hereford, 6,538 acres, £25,142 3s. 11⅛d.; Hertford, 198 acres, £562 16s. 6¼d.; Isle of Wight, 1,134 acres, £7,296 17s. 8d.; Lincoln, 421 acres, £1,086 7s. 10d.; Lynn, 18 acres, £11 11s. 2d.; Norwich, 3 acres, £0 0s. 0d.; Oxford, 21 acres, £10 0s. 0¼d; Reading, 7½ acres, £2 10s. 2½d.; Rochester, 13,474¼ acres, £113,960 18s.; Salisbury, 24¾ acres, £16 18s. 2d.; Salop, 3 acres, £6, 8s. 3¼d.; Stourbridge, 328¼ acres, £1,327 3s. 5½d.; Suffolk, 178¾ acres, £615 12s. 3¼d.; Surrey, 6 acres, £9 11s. 3d.; Sussex, 9,928½ acres, £49,857 5s. 2¾d.; Middle Wales, 26 acres, £55 10s. 11¾d.; Wellington, 48 acres, £73 18s. 4½d.; and Worcester, 1,252 acres, £5,265 17s. 11d.

The Diseases of the Hop-Plant.—Hop-plants are subject to numerous and devastating diseases; and sometimes suffer severely from them in seasons which are favourable to other field crops. Some of the apparent diseases are merely accompaniments or consequences of the real ones, and may be either harmless or positively beneficial; and some of the most virulent of the real diseases are too subtle or obscure or obstinate to be successfully combated by any known preventives or remedies. Two of the merely apparent causes of injury are the crowding of lady-birds, which feed on the aphides, and do indirect service to the hop-plants,—and the suffusion of honey-dew, which is ejected by the aphides, and can scarcely be regarded as injurious. See the articles COCCINELLA and HONEY-DEW. The principal real diseases are those popularly called the green fly, the flea, the ghost, the mould, the blight, and the fire-blast,—the former three inflicted by insects, and the other three inflicted by the weather.

The "green fly" is simply the *Aphis humuli*. See the article APHIS. The attacks of this tiny foe are sometimes tremendous, and occasionally convert a flourishing and luxuriant crop into utter desolation. The insect appears toward the end of May, and in the course of June and July; and it may sometimes be seen on the wing, in vast swarms, flying off to colonize other plantations, and seeming as if wafted on the wings of the wind. Sudden and violent falls of rain or storms of wind or of thunder sometimes subdue it; and though no thorough artificial palliative is known, aspersing the plants with pulverized lime, or syringing them with tobacco-water or soap-suds, or fumigating them with burning tobacco and sulphur, may be of considerable service. Beans have sometimes been raised between the rows of the hop-plants, with the design of their attracting the aphis; but the aphis of the bean and the aphis of the hop are quite distinct species, and of entirely different tastes and habits.

The flea, or more properly the flea-beetle, is the *Haltica concinna*, a co-species of the small flea-beetle which infests young turnips. See the article FLEA-BEETLE. The imago, or perfect insect, attacks young hop-plants, and sometimes commits great havoc upon a rising plantation. It has not yet been satisfactorily traced to its larva state; and even the habits of its imago state, and the most probable means of successfully combating it, are far from being satisfactorily known. Some persons think that it abounds most in the years in which the hop-plantations have been manured; and others think that it abounds most in seasons which are distinguished for cold nights and hot dry days. The following extract from the Rev. Dr. Hales' Treatise of Vegetable Statistics, though written about 122 years ago, narrates the phenomena of the flea's occasional appearance and devastations in the district around Canterbury, nearly as well as these are known to most observers of the present day: "In mid April, not half the shoots appeared above ground, so that the planters knew not how to pole them to the best advantage; toward the end of April, many of the hops were infested with fleas; about the 20th of May, the fleas appeared upon the leaves of the forwardest vines, but not in such numbers here as they did in most other places; and about the middle of June, the fleas increased, yet not so as to endanger the crop, but in distant plantations they were exceedingly multiplied, so as to swarm towards the end of the month." The aspersing of the young plants or young shoots with pulverized lime, as soon as the leaves begin to unfold, is probably the most efficient remedy.

The ghost-moth is the *Hepialus humuli*, a true moth or nocturnal lepidopter, and the type of a family of moths called Hepialites. The caterpillars of this family lie ensconced within the plants on which they feed, and are not often seen; the cocoon of the chrysalides generally consists of the same kind of matter which constituted the food of the caterpillars; and the antennæ of the perfect insects are short, their proboscis but slightly visible, and their wings tectiform and generally elongated. The eggs of the ghost-moth species are deposited near the roots of the hop-plant; the caterpillars feed on the roots, and sometimes cause extensive devastation among the plants; and the perfect insects are of tolerably large size,—and the superior wings of the males are silver-white and unspotted, while those of the females are yellow and have red spots. In 1826, the ghost-moth appeared in great numbers in many parts of Warwickshire. Its popular name seems to allude jointly to its habit of flying in the night and to the whiteness of the colour of the male. A boy, carrying a lighted lantern after dusk, attracts the ghost-moths round the light, and may destroy many of them by a sweeping blow with his hat; and, as they hover over limited spots, he might, if tolerably vigilant and active, clear them away from a whole plantation in the course of a few nights.

The mould, the fen, or the mouldy-fen, prevails more on hop-grounds which are low, moist, and sheltered, than on such as are high, dry, and open; and while quite a grievous calamity in itself, it is sometimes accompanied by both the aphis and the flea-beetle. "On the 27th of June," records Dr. Hales in his Vegetable Statistics, "some specks of fen appeared. From this day to the 9th of July, the weather was very dry; and the great leaves became discoloured and a little withered, and the fen somewhat increased. From the 9th of July till the 23d, the fen increased a great deal, but the flies and lice," the flea-beetles and the aphides, "decreased, it raining much daily. In a week more, the fen, which seemed to be almost at a stand, was considerably increased, especially in those lands where it first appeared. About the middle of August, the fen continued spreading where it was not before perceived, and not only the leaves, but many of the burs also, were tainted with it. About the 20th of August, some of the hops were infected with the fen, and the whole branches were corrupted with it. Half the plantations had escaped pretty well hitherto, and from this time the fen increased but little; but several days of wind and rain in the following week so distorted the plants that many of them began to dwindle, and at last came to nothing; and of those which then remained in bloom, some never turned to hops, whilst many of those which did were so small that they scarcely exceeded the size of a good large bur." The mouldy-fen, when once in possession of any part of a hop-ground, is liable to overrun the whole, and even to affect the grass and other herbaceous vegetation under the hop-plants; and, if not vigorously encountered by efforts to exterminate it, may not improbably infest the whole ground throughout a series of years. Some of the best means of resisting it—means known to be more or less efficacious since soon after the commencement of last century—are the maintaining of the soil in constant tilth and pulverulence, the assiduous suppression and extermination of all sorts of weeds, the burning of infected hop-plants in places remote from the hop-grounds, and manuring with some of the most pungent varieties of hog's dung.

The blight or the mildew infests hop-plants in a manner somewhat similar to the mouldy-fen; but though observed and investigated from remote periods, it continues to be exceedingly ill understood, and—as well as the mouldy-fen—is possibly a mere generic name for several diseases of kindred phenomena. An old work says, "It is a white dew, which falls in summer at sunrise, chiefly when the hops are in flower; its fall is so unequal, that it sometimes embraces a whole district, and sometimes only parts of it; and it dries up the hops, withers and consumes their leaves, and consequently ruins the crop." Some phytologists have ascribed it to the growth of a very minute fungus; some, to the deposition of a slimy substance by aphides; and some to the deposition of ovules and of an accompanying or sheathing liquid substance by other kinds of insects. It occurs most in weather when the days are hot and the nights are dewless. Old though disputed methods of encountering it are to sprinkle the infected plants with beech ashes, and to manure the ground with hog's dung; and a modern method, scarcely more intelligent, is to manure the ground with soot. In fact, all the diseases which affect hop-plants, and especially mouldy-fen and mildew, require yet to be scientifically investigated.

The fire-blast usually occurs in July; and sometimes scorches up whole plantations, and at other times affects only parts of plantations, or only particular portions of the plants. "Dr. Hales," says the Society of Gentlemen's Complete Farmer, "relates that he had seen the vines in the middle of the hop-ground scorched up almost from one end of a large plantation to another, when a hot gleam of sunshine came immediately after a shower of rain; and that, at such times, vapours may be observed, with the naked eye, to ascend so plentifully, as to make an object, which was before clear and distinct, become immediately dim and tremulous. It was therefore probably owing to the much greater quantity of vapours in the middle of the hop garden, than there was towards its skirts; and that middle being the densest medium, the rays of the sun may have been collected nearer to a point, by passing through that denser medium than they were in the outer parts of the ground. The course of the scorch was at right angles to the beams of the sun at about eleven o'clock, at which time the hot gleam happened. The hop-ground was situated in a valley, running from south-west to north-east; there was very little wind, and that in the course of the scorch."

Foreign Trade in Hops.—Hops imported into Britain, in a deceitful or intentionally unclean state, are liable to forfeiture. Any master of a ship who takes hops from Britain to Ireland must, under a penalty of forfeiting them and of paying a fine of 10s. per lb., carry with him a duplicate of content from his clearing-port in Britain, and lodge it with the proper officer of customs at his arrival-port in Ireland before he begin to unlade. The duty on all hops imported into Britain must be paid, and a warrant for duly landing and delivering them obtained, before they are put ashore.

Only a small proportion of the hops grown in Britain are exported; and even this is mainly sent to the British possessions in the English Channel, the Irish Sea, the West Indies, Southern Africa, India, and Australasia. The total of exports during the year ending 5 January 1845 was 153,849 lbs.; and of this, 500 lbs. were sent to Algoa bay, 821 to Antigua, 634 to Antwerp, 660 to Boulogne, 151 to Cadiz, 1,646 to Calcutta, 13,428 to Jersey and Guernsey, 4,496 to Hamburg, 595 to Havre, 12,678 to Hobart-Town, 321 to Hammerfest, 33,421 to the Isle of Man, 175 to Jamaica, 4,964 to Königsberg, 10,424 to Launceston, 153 to Madeira, 1,557 to Madras, 309 to New South Wales, 104 to Norway, 4,929 to New Zealand, 3,444 to Port-Philip, 3,450 to St. Petersburg, 860 to Portugal, 328 to Swan River, 12,464 to Sydney, 799 to South Australia, and 3,910 to Van Diemen's Land.—*The Golden Farmer.—Stevenson's Survey of Surrey.—Baxter's Library of Agricultural Knowledge.—Marshall's Agriculture of Surrey, Kent, and Sussex.—Beckmann's History of Inventions.—Coles' History of Plants.—Bulletin des Sciences Agricoles.—Dr. Hales' Treatise of Vegetable Statistics.—A. Young's Farmer's Calendar.—The Society of Gentlemen's Complete Farmer.—Knowledge Society's British Husbandry.—The Q. Journal of Agriculture.—The Gardener's Gazette.—The Farmer's Magazine.—The Farmer's Almanac.—The Journal of the Royal Agricultural Society of England.—Keith's Botanical Lexicon.—Loudon's Works.—Lawson's Agriculturist's Manual.—Marshall's Southern Counties.—The Gardener's Magazine.—The Magazine of Domestic Economy.—Bayldon on Rents and Tillages.—Buel's Farmer's Instructor.—Sir John Sinclair's General Report of Scotland.—Stephens' Book of the Farm.—Mill's Husbandry.—Anderson's Commercial Dictionary.*

HOP-BINE. See Hop.

HOP-FLY. See Hop and Aphis.

HOP-HORNBEAM,—botanically *Ostrya*. A small genus of hardy, deciduous trees, of the amentaceous order. Two species have long been grown in Britain; and one or two other species are known. The male catkin is imbricated, the calyx one-scaled, and the filaments ramose; and the female catkin is naked, the capsule imbricated and inflated, and the seed single and basal. The botanical name Ostrya signifies "a scale," and alludes to the structure of the male catkins.

The common hop-hornbeam, *Ostrya vulgaris*—called by Linnæus *Carpinus ostrya*—is a native of Italy and of North America, and was introduced to Britain in the early part of last century. Its stem usually attains a height of about 20 or 25 feet; its leaves are nearly as large as those of the common birch-hornbeam; its catkins bloom in May; and its seeds have a singular appearance while ripening, and occasion the tree to be extensively regarded as curiously ornamental. The timber is tough, compact, and heavy; and, in America, is called iron-wood, and used for making scrubbing-brushes, brooms, and levers. This tree, in its wild state in America, never grows in masses, but occurs dispersedly in forests, and abounds most in the vicinity of Lakes Erie and Ontario.

The Virginian or flowering hop-hornbeam, *Ostrya virginica*, is a native of North America, and was introduced to Britain in the former part of the 17th century. Its stem commonly rises to the height of 30 or 35 feet, and frequently attains a diameter of from 12 to 15 inches; its habit of growth is comparatively free and rapid; its leaves are larger, and of a finer tint of green, and aggregately more ornamental than those of the common species; its catkins are longish and yellow-coloured, and bloom in May and June; and its timber is similar in quality and value to that of the common hop-hornbeam. Both species are propagated either from layers, or by grafting on the common birch-hornbeam.

HOP-LIKE TREFOIL. See MEDICK.

HOP-POLES. See HOP.

HOPPER. The compartment of a sowing-machine which carries the seed-corn at the time of sowing. See the article SOWING-MACHINES.

HORDEIN. An amylaceous principle, constituting about 55 per cent. of the farina of barley. Dr. Thomson regards it, not as a distinct proximate principle, but as merely a variety of starch; and Proust regards it as strictly a proximate principle, and supposes that, in the process of malting, it is converted partly into starch and partly into sugar.

HORDEOMETER. An instrument for easily and accurately ascertaining the weight of any kind of grain which is heavier than water. It is also called a barley-measurer, a chondrometer, and a grain-sample-measurer.

The common mode of determining the weight of a measure of grain, by carefully measuring and weighing a bushel or fraction of a bushel of it in the market, is at once inconvenient, tedious, and incorrect. The mere weight, indeed, to within the 800th part of a bushel, may be readily enough ascertained by means of any tolerably good balances; but the measuring, which must accompany the weighing, is always uncertain, and may vary, with different persons, to the extent of one or even two per cent. on the bushel. Barley, in particular, varies from 1 lb. to 2 lb. in the bushel, and is correspondingly affected in real money-value, according as it is measured by a sudden plump or in a deliberate stream. In all cases of sale by sample, too—cases which involve so enormous a proportion of all the yearly produce brought to market—purchasers must encounter the additional uncertainty and loss which arise from the interested inaccuracy of the measuring and weighing of the sellers; and in the multitudes of cases in which farmers are indisposed to certify the weights—cases which comprise the great bulk of all the lighter or inferior qualities of grain—purchasers have not even the poor security of the common method of determining the weight, but must trust to the pitiful and vague criterion of touch, colour, and general appearance. Now the hordeometer is designed to rectify these serious inconveniences, and to afford a ready way of truly determining the weight of any sample of grain; and it takes its name from barley, rather than from wheat or from grain in general, on account of the excessive variations in the measuring of barley, and of the special importance of determining its weight for the purposes of malting.

Buist's hordeometer can be made of such a size as to be packed in a small box and carried in the pocket to the market; and it professes to test one ounce of barley to within the 500th part of its true weight, so as to give a result tenfold freer from error than the common method of manipulating with a whole bushel. It acts on the simple principle of substituting a measure of water for an equivalent measure of barley; it requires at least 400 or 500 grains of barley to be employed in order to insure minute accuracy; and it serves also for any samples of wheat, oats, rye, pease, or beans which are heavier than their equivalent measure of water,—and likewise for spirits, wines, ales, or any other liquids of whatever density or tenuity. It consists of a long-neck glass phial, similar in form to the bottles of Eau de Cologne, and of a capacity to contain from 3 to 4 ounces of water; a thick glass-tube or meter, blown out at the lower end into a bulbous form, with the extremity downward from the bulb tapering to a fine capillary point, and of a capacity not more than one-third of that of the phial; and either an apothecary's pair of scales, a spring balance, a steel-yard, or any other small and convenient weighing apparatus of sufficient delicacy to indicate about half a grain troy. The neck of the bulb is marked with a diamond, at the carefully ascertained equivalent of water for an amount of barley of thoroughly ascertained weight and measure; the phial is marked with a diamond at two and at three of the same equivalents; and the steel-yard or other weighing apparatus is marked with carefully determined graduations of weight. In using the instrument, the phial and the bulb are suspended on the weighing apparatus, the phial is filled with water to the mark for two equivalents, barley is filled into the phial till the surface of the water stands at the mark for the third equivalent, and the weight is moved upon the limb of the weighing apparatus till the whole is precisely balanced.

HORDEUM. See BARLEY.

HOREHOUND,—botanically *Marrubium*. A genus of plants, chiefly hardy perennial-rooted herbs, of the labiate order. Eight species formerly included in it, are now assigned to the genus Beringeria; and about a dozen species still belong to it,—one indigenous, the others exotic,—and all to be found in the botanical collections of Britain. All have either purple or white flowers, and possess some degree of ornamental character; and some of the foreign species, particularly the Alyssum and the Cretan horehound, have been very long in British gardens.

The common white horehound, *Marrubium vulgare*, grows wild on commons, on dry waste grounds, on dry parts of road-sides, and in many sorts of dry rubbishy spots in Britain. Its root is fibrous and perennial; its stems are numerous, erect, quadrangular, very downy, and about 18 or 24 inches high; its leaves are in pairs, broadly-petiolate, rounded, crenate, wrinkled, hoary above, and tomentose below; and its flowers grow in dense convex axillary whorls, and are sessile, villous, and white, and bloom from June till September. This plant has a high medicinal reputation among the peasantry, and also holds a place in both the Edinburgh and the

Dublin pharmacopœias. It is not eaten by any of the domestic animals; and is cut and dried before being used in medicine. The dried plant has a bitter taste and an aromatic odour, but soon loses the latter by keeping; it possesses tonic, diuretic, and laxative properties; and it seems to owe all its powers to a bitter extractive, a volatile oil, and gallic acid. It was formerly recommended for hysteria, jaundice, and menstrual obstructions, and is still popularly used for asthma, obstinate coughs, and pulmonary complaints; but though it may sometimes be of appreciable service in these diseases, it exerts no such power over them as to be deserving of the physician's notice.

HOREHOUND (Stinking). See Ballota.

HOREHOUND (Water),—botanically *Lycopus*. A genus of herbaceous plants, of the labiate order. The European species, or gipsywort, *Lycopus Europæus*, grows wild on the sandy or gravelly banks of streams, pools, and clear ditches in Britain. Its root is creeping and perennial; its stem is 2 or 3 feet high; its leaves are numerous, oblong, pointed, deeply serrated, and frequently pinnatifid; and its flowers have a white ground colour with purple dots, and bloom in July and August. Four or five species, all perennial-rooted, white-flowered, and slightly ornamental, have been introduced from Continental Europe, North America, and New Holland.

HORKELIA. A recently discovered genus of ornamental plants, of the rosaceous order. The plants of it are herbaceous and erect, and present some resemblance, in their general aspect, to potentillas; but they have a campanulate calyx, unguiculate petals, and ten stamens, and produce their flowers in capitate groups or masses; and they really occupy a middle place between the potentillas and the sibbaldias, and assist to establish a graduated series of structure between the most highly developed forms of the rosaceæ, and such low forms as occur in the sanguisorbeæ. The crowded-flowered species, *H. congesta*, is a native of the western wilds of North America, and was introduced to Britain in 1826. It is a hardy, curious, perennial-rooted, white-flowered herb, about two feet in height, and blooming in early autumn. Four other species, *H. fusca*, *cuneata*, *hirsuta*, and *capitata*, were brought to Britain from California, previous to 1838; and all may be readily propagated, either from seeds or by division of the roots.

HORMINUM. A small genus of herbaceous plants of the labiate order. It is nearly allied to the balm genus, and takes its name from its inciting properties. The Pyrenean species, *H. Pyrenaicum*, is a hardy, perennial-rooted, blue-flowered, ornamental, summer-bloomer, of about two feet in height; and was introduced to Britain, nearly 30 years ago, from the Pyrenees. A red-flowered, weed-looking species was introduced, about 15 years ago, from North America.

HORMINUM-CLARY. See Clary.

HORN. The term *horn*, as applied in the arts, would exclude the excrescences of the stag, deer, rein-deer, elk, and others, which consist rather of a bony substance, distinguished by the term *antler*. The horns of this division of ruminants are true bones, and composed like them of a cartilaginous matter, within the meshes of which, particles of phosphate of lime are deposited, constituting a kind of earthy salt, commonly known as earth of bones or hartshorn. These antlers, in their perfect state, are true bones both in their texture and elements, the external part being hard, compact, and fibrous; the internal spongy, but very solid. There are no large cells, medullary cavities, or sinuses. The bases of these antlers adhere to the frontal bone, forming one body with it, in such a way as to render it impossible to point out, at certain ages, the limits between them. The skin which covers the forehead does not extend farther. It is surrounded by a denticulated bony substance, called the *burr*. Neither skin nor periosteum covers this substance or the rest of the antler. Furrows more or less deep, which are the vestiges of vessels distributed along their surfaces while they were yet soft, are alone to be traced on the exterior. These hard and naked horns remain only for one year on the head of the stag. The period of their fall is varied according to the species; but when near, there appears, on sawing them longitudinally, a reddish mark of separation between them and the supporting eminence of the frontal bone. This mark becomes gradually more apparent, and the bony particles at length lose their adhesion at that part. A very slight shock then makes the antlers drop off at that period, and two or three days commonly intervene between the fall of the one antler and that of the other. The eminence of the frontal bone resembles, at that time, a bone broken or sawed through transversely, and its spongy texture is exposed. The skin of the forehead soon, however, covers it; and when the horns are again about to shoot, tubercles arise, which remain covered by a production of the same skin until their perfect size has been attained. During the whole of this operation, the tubercles are soft and cartilaginous. Under the skin a true periosteum is found, in which vessels, sometimes of great size, are distributed, and penetrate the mass of cartilage in every direction. The cartilage ossifies gradually, and passing through the same stages as the bones of the fœtus, ends in becoming a perfect bone. During this time, the burr at the base of the horn penetrates the indentations through which the vessels pass, and also develops itself. The indentations by their growth confine the vessels, and finally obstruct them. Then the skin and periosteum of the bones wither, die, and fall off. The bones, now become bare, in a short time fall off, only to be renewed by others, but always of a larger size than the first. The antlers of the stag are subject to diseases equally with other bones, and of the same kind. In some the calcareous matter is extravasated, and forms different exostoses; in others, on the contrary, it is found in too small a quantity, and the bones continue porous, light, and without consistence.

The true horns, such as those of the bull, ram, goat, and chamois, are formed upon processes of bone, and differ materially from antlers in this respect, that they grow at their root or base, and bear a great analogy to the other integuments. This view is established by investigating the manner in which the horns of the calf exhibit themselves. In the third month of conception, while the fœtus of the cow is still enclosed in the membrane, the cartilaginous frontal bone presents no mark of the horns which it afterwards bears. It becomes partly ossified towards the seventh month, and presents in its two portions the small tubercle, which appears to be produced by the elevation of the osseous laminæ. These bony tumours soon after appear externally, and raise the skin in proportion as the tumour grows. At last it becomes horny as it elongates, and forms a kind of sheath which covers externally the process of the frontal bone. There are numerous branches of blood-vessels, which serve to nourish the bony part, and are placed between this sheath and the frontal bone. Thus the horns are merely solid, hard, elastic, and insensible sheaths, which protect the osseous prolongation of the frontal bone. These sheaths, generally of a conical figure, are broadest at the base, or extremity from which they grow. The curvatures assumed by the horns are different in the several species; they also present different channels or transverse furrows, depending on the age of the animal; and these denote, in a very certain manner according to the species, the number of years it has lived. The horns grow in precisely the same manner as the nails of animals and the beaks of birds; that is to say, from the bone which serves as a base there exudes a gelatinous matter, which takes the form of the horn, and hardens on coming in contact with the air. M. Vauquelin has found this gluten, or animal mucus, to be of precisely the same chemical nature as that found in hair.

The texture of the horns appears to be much the same in the ram, goat, antelope, and bull. They consist of fibres of a substance very analogous to hair, and appear to be agglutinated in a very solid manner. These fibres in the two genera first mentioned are short, and covered by superincumbent layers like the tiles of a house. In the last two they are longer, more compact, and form elongated cones, the one being incased within the other. It appears that the horns of the rhinoceros differ materially from those of the ruminantia. They have no osseous part, and are not placed upon the frontal bone, but upon the ridge of the nose. They are formed, however, of the same substance, and we observe fibres analogous to hairs more distinctly in this animal than perhaps in any other. The base of the horn presents externally an infinite number of rigid hairs, which seem to separate from the mass, and render that part rough, like a brush, to the touch. When sawed transversely, and examined with a magnifying glass, we perceive a multitude of pores, seeming to indicate the intervals resulting from the union of the agglutinated hairs. When divided longitudinally, there are numerous parallel and longitudinal furrows, which demonstrate a similar structure. This kind of horn is attached solely to the skin. The horns of the two-horned rhinoceros, *Rhinoceros bicornis*, always appear in some degree moveable. When fixed, as in the Indian rhinoceros, *R. Indicus*, there is a thick mucus interposed between its base and the bone over which it is situated. The whale-bone, which lines the interior of the upper jaw in the whales, also consists of hair united into laminæ.

The colour of horns depends, like that of the hairs, on the colour of their mucous tissue. Heat softens bone, and even fuses it; hence this agent is largely employed in manufacturing them into different articles.

It appears from these observations, that true horns differ essentially from the bony prolongations called *antlers* in the deer. The latter increase at their extremity, and are covered with skin during their growth. They fall off when their growth is completed, and are replaced by others. The true horns are developed at the base, are covered with skin, and remain permanently.

The different forms of the horns of cattle are adopted as the distinctive marks of classes and breeds; and certain observable increments of growth are regarded as criteria of the age of individuals. See the articles CATTLE and AGE OF ANIMALS. The uses of the horns of slaughtered cattle are many and important. "The tanner who has purchased the hides," says Babbage, "separates the horns, and sells them to the makers of combs and lanterns. The horn consists of two parts; an outward horny case, and an inward conical-shaped substance, somewhat between hardened hair and bone. The first process consists in separating these two parts, by means of a blow against a block of wood. The horny outside is then cut into three portions by means of a frame-saw. 1st, The lowest of these, next the root of the horn, after undergoing several processes, by which it is rendered flat, is made into combs. 2d, The middle of the horn, after being flattened by heat, and its transparency improved by oil, is split into thin layers, and forms a substitute for glass in lanterns of the commonest kind. 3d, The tip of the horns is used by the makers of knife handles and the tops of whips, and similar purposes. 4th, The interior or cone of the horn is boiled down in water. A large quantity of fat rises to the surface; this is put aside, and sold to the makers of yellow soap. 5th, The liquid itself is used as a kind of glue, and is purchased by the cloth-dresser for stiffening. 6th, The bony substance which remains behind is ground down and sold to the farmers for manure. Besides these various purposes to which the different parts of the horn are applied, the chippings which arise in comb-making are sold to the farmer for manure at about one shilling per bushel. In the first year after they are spread over the soil, they have comparatively little effect; but during the next four or five, their efficiency is considerable. The shavings which form the refuse of the lantern-makers, are of a much thinner texture. A few of them are cut into various figures, and painted and used as toys, for they curl up when placed in the palm of a warm hand. But the greater part of these shavings are sold for manure, which, from their extremely thin and divided form, produce its full effect upon the first crop."

HORNBEAM,—botanically *Carpinus*. A genus of useful and ornamental timber-trees of the birch division of the amentaceous order. Both the male and the female catkins are imbricated; the male is ten-stamened, and has the scale of its calyx ciliated; and the female has a two-flowered calyx-scale, and a three-cleft corolla, and is succeeded by an ovate, angular, furrowed nut. One species is a native of Britain; two have been introduced from other countries; and one or two more are known.

The common species, or birch-hornbeam, *Carpinus Betulus*, is an indigen of British woods, and of many parts of Continental Europe and North America. It grows and flourishes in exposed situations, and among poor, cold, thin, damp soils, where most other forest-trees would starve; it accommodates itself to a very wide diversity of circumstances; and it attains a comparatively great height and vast bulk on rich marly clay. Its stem, in average situations, attains a height of from 50 to 70 feet; its branches are long, flexible, and crooked, yet have a very close resemblance, in general appearance, to those of the birch; and its leaves have a darkish-green colour, and are about the same size as those of the beech, but more pointed, and deeply serrated,—and they continue to adhere to the branches long after they have ceased to circulate sap or perform their vegetative functions. It may be trained to any reasonable height; and, when kept trimmed on the sides, it becomes crowded with branchlets and very thick with foliage; it is less reflective of heat, and affords a more uniform temperature of shade and shelter than a piece of brick-wall; and, for these reasons, jointly with the persistency of its leaves, it forms excellent screen-fences for the sheltering of gardens, nurseries, and young plantations from the severities of winter, and is equal or even preferable to birch for planting promiscuously or in alternate rows among more tender trees in exposed situations. It is said, by some old foresters, to be peculiarly grateful to hares and rabbits, and to be much disliked by deer. It seems not generally suited to the forest; and it ranks far below many other hardy trees for purposes of ornament; yet it may be advantageously grown for its timber on some poor soils and exposed situations, and would group somewhat well with other trees in various parts of parks. It is cultivated chiefly for hedges and underwood; and, in its shrubby state, it presents so close a resemblance to shrubby beech, as to be readily distinguishable only by its want of the glossy varnish which coats the beech leaves. Its forest timber is hard, tough, and valuable for many useful purposes, but can seldom be obtained by the carpenter; and its underwood timber is excellent for mill-cogs, yokes, heads of beetles, handles of tools, and all similar objects, and is good fuel, makes superior charcoal, and yields excellent potash. It may be propagated either from seeds sown in autumn, or by layering at almost any time of the year.

Three permanent varieties of the common hornbeam are in cultivation; but they possess interest distinct from the normal plant, chiefly on account of their peculiarities of foliage, and of some curious exemplifications which they afford of the laws of vegetation.—The cut-leaved variety, *C. b. incisa*, usually attains but half the height of the normal plant. The variegated variety, *C. b. variegata*, never occurs in a wild state, and usually attains a maximum height of about 20 or 25 feet. The oak-leaved variety, *C. b. quercifolia*, was introduced from Continental Europe, and is capable of rising to the same height as the normal plant, and blooms in May and June.

The American hornbeam, *Carpinus americana*, occurs wild in America, as far north as Nova Scotia, New Brunswick, and Lower Canada, and was introduced to Britain about 34 years ago. It is the most elegant of all the hornbeams in Britain; but it never exceeds 30 feet in height, and seldom attains sufficient dimensions to rank as a forest-tree. Its branches are slender, and covered with a brownish speckled bark, and are more sparingly sent forth than those of the common hornbeam; and its leaves are oblong, pointed, of a palish-green colour, and not nearly so rough as those of the common species.

The eastern hornbeam, *Carpinus orientalis*, is a native of the Levant, and was introduced to Britain upwards of a century ago. It seldom attains a height of more than about 12 feet; and has a sufficiently agreeable appearance among tall shrubs or dwarfish trees. Its leaves are a good deal smaller than those of the common hornbeam; its branches are closer in proportion to the smallness of the leaves; and its bark is more spotted, and contributes a little to piquancy of appearance. This species does even better than the common one for a deciduous close-branched hedge, either to be kept shorn, or to be allowed to grow with natural scope and luxuriance.

HORNBLENDE, or AMPHIBOLE. One of the most abundant and widely-diffused substances in the mineral kingdom, next to quartz, felspar and mica, and is very remarkable on account of the various forms and compositions of its crystals and crystalline particles, and of its exceedingly diversified colours, thus giving rise to almost numberless varieties, many of which have obtained distinct appellations.

The primitive form of the species is an oblique rhombic prism of 124° 30′ and 55° 30′, in which the terminal planes are inclined to the obtuse lateral edges, under angles of 105° and 75°. The former planes are easily developed, by cleavage from its crystals and crystalline masses; but the latter have never been obtained in this way, having been inferred from calculation. The crystals of hornblende are generally long, and destitute of regular terminations; they are often deeply striated longitudinally, and much disposed to intersect each other, sometimes in such a manner as to give rise to a sheaf-like or to a stellular composition. Perfectly regular, implanted crystals do occur occasionally; and these present, for the most part, the following shapes: six-sided prisms, from the truncation of the acute lateral edges of the prism, acuminated by four planes, corresponding either to the lateral edges or to the lateral faces of the prism; the same with an acumination of three planes; the same with dihedral summits; and the primitive form with dihedral terminations, of which the faces correspond to acute edges of the prism. The massive varieties frequently offer a granular structure, in which the individuals are of various sizes, and strongly coherent, often with a tendency to a slaty fracture; more commonly, however, the composition of massive varieties is columnar, the individuals being sometimes very long, parallel or diverging, and, when delicate, producing a silky lustre. The lustre of hornblende is vitreous, inclining to pearly, upon the faces of cleavage, in the varieties possessing pale colours. Colour, various shades of green, often inclining to brown, white, and black, with every intermediate shade; nearly transparent in some varieties; in others opaque; brittle; hardness, about the same with felspar; specific gravity, 3·00. Three varieties, analysed by Bonsdorf, gave the following results:—

	A white variety.	*A green variety.*	*A black variety.*
Silex, . .	60·31	46·26	45·69
Magnesia, . .	24·23	19·03	18·79
Lime, . .	13·66	13·96	13·85
Alumine, . .	0·26	11·48	12·18
Protoxide of iron,	0·15	3·43	7·32
do. of manganese,	0·00	9·36	0·22
Fluoric acid. .	0·94	1·60	1·50
Water and foreign substances,	0·10	1·04	0·00

Of those varieties of the present species which have obtained distinct names, and which, in some systems of mineralogy, have even been regarded as forming separate species, the following are the most remarkable, viz., *hornblende, tremolite, actinolite,* and certain kinds of asbestos. Hornblende differs from the rest principally by its dark, blackish, or greenish colours, and is divided into three subvarieties, *basaltic hornblende, common hornblende,* and *hornblende slate.* The first consists of black and perfectly-cleavable crystals, which are always found imbedded in basaltic or volcanic rocks; the second refers to imbedded crystals of various colours, but always of dark shades, and in which cleavage is less easily obtained; it includes, besides, all massive, granular, or columnar varieties, except such as are black, easily cleavable, and of a shining lustre, which have been distinguished by the name of *carinthin.* Hornblende slate comprehends such varieties as consist of minute and closely-aggregated particles, united in such a manner as to produce a slaty fracture. Tremolite consists of the pale green, grey, bluish and white varieties, and has been subdivided into *common, glassy, asbestiform,* and *granular* tremolite. The first occurs in crystals, rarely with perfect terminations, and in massive varieties; the second in columnar compositions, or coarsely fibrous, with a high degree of transparency; the third refers to very thin or capillary crystals; and the fourth consists of granular particles. The varieties of actinolite differ from those of tremolite by their deep (often grass-green) colours. The asbestiform tremolite and asbestiform actinolite form a passage into asbestos, which term is applied not only to minute, columnar, and variously interwoven individuals of this species, but to those also of augite or pyroxene, and may be said to denote rather a peculiar state of aggregation in these species than the substance of a distinct mineral. The best crystals of basaltic hornblende come from near Teysing and Teplitz, in Bohemia. Common hornblende abounds in Arendal, and other places in Norway and Sweden; a light greenish variety, imbedded in granular limestone, at Pargas, in Finland, has received the name of *pargasite.* The varieties of actinolite and tremolite abound in numerous places in Europe; the former occurring in talcose slate, and the latter in limestone and dolomite rocks. In the United States, this species is also widely disseminated.

HORNED-PONDWEED, — botanically *Zannichellia.* A small genus of aquatic plants of the order Fluviales. The marsh species, *Zannichellia palustris,* is an annual indigen of the ditches and ponds of Britain. Its root is slenderly fibrous; its stem is ramose, filiform, floating, and about 18 or 24 inches long; its leaves are smooth, acute, and very narrow; and its flowers are apetalous, and appear in July. The plant is generally submersed, but rises when in bloom.

HORNED-POPPY. See Horn-Poppy.

HORNEMANNIA. A small genus of beautiful, annual, exotic plants, of the figwort family. The two-coloured species, *H. bicolor*, is a native of India; and was introduced about 30 years ago to Britain. Its stem is only 2 or 3 inches high; and its flowers are blue, and bloom from June till September. Two introduced small trailing annuals, the one hardy and the other requiring frame or greenhouse heat, are assigned by some botanists to the genus hornemannia, and by others to the genus tittmannia.

HORNET,—scientifically *Vespa Crabro*. A dreadfully waspish insect, of the diplopterous family of hymenopters. It belongs to the same genus as the common wasp; and is the fiercest and most formidable species of that ferocious and poison-stinged genus. Its length is about one inch; it head is fulvous, but has a yellow front; its thorax has a black ground-colour, and fulvous spots; and its abdomen has blackish-brown rings, and is marked with a yellow band, dotted with two or three black points on its posterior margin. This insect was formerly abundant in many parts of England; but it is now becoming scarce in some of these parts; and it seems to be quite unknown in Scotland. It resembles the common wasp in general habits; but differs from it in some particulars. Its retreat is the hollows of trees, holes in walls, barns, garrets, and similar places; its nest is rounded, formed of coarse materials, and similar in colour to a dead leaf; and its honey-combs are few in number, and connected together by means of a kind of pillars. The hornet naturally feeds, like other insects of its tribe, upon the nectareous juices of flowers and fruits; but it usually practises a truculent and thievish method of obtaining them, and habitually attacks hive-bees and other honey-gathering hymenopters, and sucks the honey and moisture from their bodies. It particularly challenges the notice of farmers and cottiers by its devastations among honey-bees, and by its occasional attacks upon horses and cattle. The sting of the hornet occasions great pain; and this may be alleviated in cattle by the application of warm vinegar,—and in horses, by the application of oil of turpentine.

HORN-GRASS. See Ceratochloa.

HORN OF PLENTY. See Fedia.

HORN-POPPY,—botanically *Glaucium*. A genus of very showy, hardy, annual and biennial plants, of the poppy family.

The yellow horn-poppy, *Glaucium flavum* or *Glaucium luteum*, is a biennial, and grows wild on the sandy shores of Britain. Its root is fusiform; its stem is cylindrical, branched, leafy, very glaucous, and about 2 or 3 feet high; its radical leaves are numerous, petiolate, greyish, pinnatifid, lyrate, cut, hairy, and about a span long; its stem leaves are sessile, lobed, cut, less rough, and comparatively short and broad; its flowers are yellow, and spread out in the manner of the common poppy, and bloom from June till October; and its pod is 9 or 10 inches long, curved, roughish with minute tubercles, and somewhat similar in appearance to a horn,—and hence, jointly with the flower, giving the plant the popular name of horn-poppy. The whole plant is very glaucous; and, when broken, emits a large quantity of yellow juice.

The purple horn-poppy, *Glaucium Phœniceum*, called by Linnæus *Glaucium corniculatum*, is a rare native annual of the sandy fields of some parts of England. Its root is tapering; its stem is more erect than that of the yellow species, and is covered with spreading hairs, and has usually a height of about 2 or 3 feet; its leaves are oblong, hairy, pale green, and deeply and irregularly pinnatifid,—and the upper ones are sheathing; the flowers have hairy pedicles, hairy calyxes, and rich scarlet coloured petals, marked at the base with an oblong black spot, and both narrower and smaller than those of the yellow species,—and they bloom in June and July; and its pod is profusely armed with small, rigid, silky bristles. "The foliage of this plant," remarks Miller, "is very elegant, and might be introduced by way of ornament to furniture with great advantage, being very picturesque; it may also be wrought into patterns for silks, and painted upon porcelain, where it would have a very good effect." A variety of this species, with yellow and red flowers, and only about 15 inches high, and called *G. p. flaviflorum*, was introduced about 24 years ago from Tauria.

The violet horn-poppy, *Glaucium violaceum*, is a somewhat scarce annual indigen of the corn-fields of England. Its root is slender; its stem is erect, cylindrical, smooth, and about a foot high; its leaves are commonly opposite, of a lucid dark green colour, and twice or thrice pinnatifid; its flowers come out on slender peduncles from the wings of the leaves, and have a brilliant violet blue colour, and a splendid appearance, but are exceedingly fugacious, seldom lasting longer than 3 or 4 hours; and its pods are cylindrical, 2 or 3 inches long, and clothed with small bristly prickles.

Two species, the red and the tawny, *Glaucium rubrum* and *Glaucium fulvum*, the former a red-flowered annual of about a foot in height, and the latter an orange-flowered biennial of about two feet in height, have been introduced from the south and south-east of Europe. All the species are readily propagated from seeds, in the ordinary manner of hardy annuals.

HORNWORT. See Ceratophyllum.

HORSE,—scientifically *Equus*. A genus of quadrupeds, of the uncleft-footed family, thick-skinned order, hoofed tribe, and suck-giving class of vertebrated animals. It comprises six species, —*Equus caballus* or the proper horse, *E. asinus* or the ass, *E. hemionus* or the dziggnetai, *E. zebra* or the zebra, *E. quaccha* or the couagga, and *E. montanus* or the onagga or dauw. The characters which distinguish these species from one another, though sufficient for the purposes of the naturalist, possess exceedingly little anatomical importance; and the chief of them are superficial, and consist in the comparative size of the ears, the length and texture of the hair, and the distribution of the external colours. But all the internal characters of the several species are so much alike, and even the size of the individuals of a species is so remarkably variable, that the most skilful comparative anatomist is scarcely able to distinguish a species from the inspection of a few equine bones. Fossil equi, also, possess only such characters as render it exceedingly difficult to determine whether they belonged to extinct or to existing species. Four of the existing species of equi are undomesticated; the ass species and a hybrid between it and the proper horse, form the subjects of our articles Ass and Mule; and only the proper horse species, *Equus caballus*, forms the proper subject of the present article.

History of the Horse.—Fossil bones, supposed by some geologists to be those of the horse, have been found in various parts of the world, buried deep in depositions of an older date than the era of the creation of man. Some also have been recently discovered in America, mixed with those of extinct species of animals; and a large quantity occur in the celebrated Kirkdale cave in Yorkshire, mixed with those of the ox, the deer, the elephant, the rhinoceros, and the hyæna. But the American specimens belonged either to an extinct species of the horse genus, or to an extinct race of an existing species; and the British specimens seem to have belonged to animals which lived in a very different climate from that which Britain now enjoys. Buckland remarks, too, that the latter, as well as those of other animals found along with them, appear to have been fractured by the hyæna, in order to the extraction of their marrow; and he infers, from the total absence of human bones in their vicinity, combined with the known passion of the hyæna for plundering human burying-grounds, that the fossil horses of Britain must have lived at a time prior to this country being inhabited by man. Some apparently equine fossil bones, likewise, have been found at Hatfield in Yorkshire, and in the Isle of Dogs in Middlesex; but they have an obscurer character than those of the Kirkdale cave.

Some naturalists, partly on the evidence of the wide diffusion of the equine fossil bones, and partly on that of the known adaptation of the living animal to widely different climates and countries, contend that the horse is a sort of general native of the world. Dr. Fleming, for example, says, "That the horse should be regarded as indigenous," in Britain, "need scarcely require proof; it lives and propagates, nearly in a state of nature, in the Highlands of Scotland, and the Zetland Islands; and the remains of the species occur associated with those of the most ancient of our quadrupeds." But the equine fossil bones cannot, in even one instance, be certainly identified with the *Equus caballus;* and the existing adaptation of the horse to different countries and climates, is, in some instances, the result of direct processes of acclimatation, and, in many, the accompaniment of the diversities of character and the peculiarities of constitution which determine the varieties or breeds of the species. See the articles Acclimatation of Animals and Breeding. "Nature," remarks Winter, "has bestowed on this noble animal a constitution capable of withstanding the vicissitudes of a wide range of temperature; and so extensive is his geographical distribution, so numerous his varieties, that it has become impossible to declare with certainty either his primitive country or his original breed. He has extended himself, apparently with equal facility, over lands characterized by great diversity of soil and climate; and his numerous varieties or breeds seem to flourish alike in localities to which they have been gradually modelled by the hand of time, through the succession of numberless generations." Hence, even the great majority of naturalists who suppose the horse to have originally existed within narrow limits, differ widely in opinion as to the particular region of his native country. Some, looking at the earliest historical mention of the horse, identify that region with Egypt; some, looking at the finest existing natural breed of the species, identify it with Arabia; and some, looking at the most decided modern instances of a truly wild condition, identify it with the barren steppes of Crim Tartary. The last of these classes is the most eminent, and boasts the names of Humboldt, Pallas, and others of greatest distinction.

Wild horses are supposed by Cuvier to exist only in places where they were formerly domesticated, and were afterwards set free from all restraint; yet they occur, in great troops, not only in America, where they are known to have descended from a domesticated stock, but in many parts of Asia, and even in some parts of Africa and of eastern Europe. The droves of wild horses, in the bleak and inhospitable steppes of Tartary, are prodigious in number, and do not possess a trace of domestication. The wild horses of Thibet are about 13 hands high, and of a prevailingly fawn colour, and have thick, short, and well-carried heads; and those of the country between the Jaik and the Wolga, have colours ranging between fawn and reddish-brown. Wild horses have been seen in northern China, in central Africa, and even in the Hungarian part of eastern Europe. "There," says Riesbeek, in reference to the last of these regions, "you meet with deserts, in the midst of which, as in those of Tartary, are troops of wild horses; these beasts are small, light, but not handsome."

The wild horses of America sprang originally from a dozen individuals which were let loose by the Spaniards at the relinquishment of Buenos Ayres, and from such other individuals as afterwards joined that small stock; and they have eventually multiplied into such numbers, and spread themselves from tract to tract with such freedom, that they are now to be found throughout the extensive savannahs or prairies of all the central parts of South America, and beyond the isthmus of Panama, and even within the great North American basin of the Mississippi. They associate in large herds; and display much of the high spirit of the Spanish breed from which they have sprung; and often perform evolutions of great nobleness and beauty. "Instead of flying as the deer and other timid animals, they gallop round in compact masses of many thousands, apparently for the purpose of reconnoitering the strangers, and frequently advance boldly to within a few yards of the line of march, when they halt to gaze at the troops, snorting, and showing every sign of astonishment and displeasure, especially at the sight of cavalry." Some wild horses recently wandered in the forests of some parts of Jamaica and Hayti; and a few, which have sprung from domesticated individuals let loose by colonists in the seventh decad of last century, still exist on the Falkland Islands.

The earliest allusion to the horse is an incidental mention of mules—the hybrid offspring of him and the ass—in the Mosaic notice of Anah, the son of Zibeon, and a contemporary of Isaac; the earliest express mention of him records that "Joseph gave the Egyptians bread in exchange for horses, and for the flocks, and for the cattle of the herds, and for the asses;" and the earliest notice of his having become so domesticated and trained as to be ridden, occurs in Jacob's dying benediction on his sons,—"Dan shall be a serpent by the way, an adder in the path, that biteth the horse heels, so that his rider shall fall backward." But the well-known description of the war-horse in the book of Job, indicates that, in the days of that patriarch, the horse had become as superb a trained animal as in our own; and it, at the same time, so immeasurably transcends all uninspired poetry in beauty and sublimity as to cover the early history of the horse with a peculiar and most dazzling glory,—only the word "thunder" in our common English version of the passage, must be substituted by the phrase "beautiful mane,"—and whoever has observed the effect of a spirited horse's mane at a moment of excitement, will appreciate the allusion to it:—"Hast thou given the horse his strength? Hast thou clothed his neck with his beautiful mane? Canst thou make him afraid as a grasshopper? The glory of his nostrils is terrible. He paweth in the valley, and rejoiceth in his strength. He goeth on to meet the armed men; he mocketh at fear, and is not affrighted; neither turneth he back from the sword.' The quiver rattleth against him, the glittering spear and the shield; he swalloweth the ground with fierceness and rage; neither believeth he that it is the sound of the trumpet. He saith among the trumpets, Ha! ha!—and he smelleth the battle afar off, the thunder of the captains, and the shouting."

Horses appear from this passage in Job to have been then used for the purposes of war; they appear from another passage in Job to have been then used also for hunting; and they appear, from a passage in reference to the king of Egypt, in less than 20 years afterwards, to have been distributed into the three classes of select chariot horse, common chariot horse, and cavalry horse,—"Pharaoh took six hundred chosen chariots, and all the chariots of Egypt, and captains over every one of them; and the Egyptians pursued after the children of Israel.—all the horses and chariots of Pharaoh, and his horsemen, and his army."

The horse, probably, was first domesticated in Central Asia, and spread, in his domesticated state, from Cashmere and the Upper Oxus to China, India, and Egypt, and first underwent, in the last of these countries, those processes of artificial improvement which issued in his finest breeds. "To ancient Egypt," remarks Colonel Smith, "we appear to be indebted for the first systematic attention to reviving and improving the breeds of horses. Numerous carved or outlined figures represent steeds whose symmetry, beauty, and colour attest that they are designed from high-bred types." The Israelites were forbidden to use horses for either battle or pleasure, and commanded to hamstring such as they captured in war; yet, about five centuries after their exodus from Egypt, they so fondly domesticated horses and so greatly multiplied them that Solomon had 1,400 chariots and 12,000 cavalry. The Egyptians, the Ethiopians, the Medes, the Persians, and the Greeks, successively paid great attention to horses, and maintained them in a spirited and well-trained condition for the purposes of war and of the chase; the Greeks introduced either fine breeds of horses themselves, or a taste for possessing and improving them, into Arabia, Barbary, Spain, and Southern Italy; and the Romans afterwards diffused them throughout the central, the western, and the northern parts of Europe.

When Julius Cæsar invaded Britain, horses were possessed in large numbers by the Britons, and were in a state of high discipline for the draught of the war-chariot, and excited so much admiration in the conqueror, that he took some with him to Rome in order to improve the Roman breeds. Whether the Britons obtained their breed from Continental Europe, or whether they had worked it out by assiduous attention to crossing from the aborigines of the present shelties of Scotland, or ponies of Wales, or hobbies of Ireland, is not known. The multitudes of horses of various breeds introduced to Britain by the Romans, would more or less intermix with the British horses, and gradually change their character; so that the latter must have eventually become a compound of the true British breed, and the breeds of Gaul, Spain, Italy, and other parts of the Roman Empire. In the 7th century, according to Bede, "the bishops and others in England rode on horseback, who until then were wont to go on foot; and even then it was only on urgent occasions that they thus rode; and they used mares as a mark of humility, the mare generally not being so handsome or so much valued as the horse." In the reign of Alfred the Great, a public officer, called the Horse-Thane, was appointed for the special purpose of attending to the improvement of the breeds and discipline of the horse; and in subsequent reigns, this officer was always kept near the person of the monarch. Athelstan, the natural son of Alfred, received from France several German running horses, and seems to have crossed them with the British breeds, and soon placed so great a value on the latter as to prohibit their exportation in any way except as royal presents. "It is not unlikely," remarks Youatt, "that even at this early period, the beautiful effect of the English soil and climate, and care in the improvement of the horse, began to be evident; for the experience of every age has proved that there are few countries in which the native breed has been rendered so much more valuable by the importation of a foreign stock, and every good quality of a foreign race so certainly retained, as in England."

William the Conqueror owed the victory of Hastings, in a main degree, to the superiority of his cavalry; and the barons who accompanied him, being made landowners of a very considerable portion of the kingdom, rapidly diffused a valuable mixture of the characters of the Norman and the Spanish horses among the British breeds. A piece of Bayeux tapestry, woven in the time of William the Conqueror, contains a figure of a horse drawing a harrow, and is the earliest record of the horse being used in field labour; and a Welsh law of nearly the same period forbade farmers to plough with horses, mares, or cows, and enjoined them to plough only with oxen. In 1121, the first record occurs of the introduction of an Arabian horse to Britain; and during the crusades, large importations of horses were made from the Levant. The regular traffic in horses in the home-markets of England now commenced; Smithfield was devoted to the purposes of horse-jockeyism, horse-racing, and tilting; and dealing in horses became a regular avocation, and speedily fortified and disgraced itself with some practices of trickery. "Every Friday, except some festival intervene," said Fitzstephen about this period, "there is a fine sight of horses brought to be sold. Many come out of the city to buy or look on,—to wit, earls, barons, knights, and citizens. It is a pleasant thing to behold the horses there, all gay and sleek, moving up and down, some on the amble, and some on the trot. Here also are colts, yet ignorant of the bridle, which prance and bound, and give early signs of spirit and courage. Here also are managed or war horses, of elegant shape, full of fire, and giving every proof of a generous and noble temper. Horses also for the cart, dray, and plough, are to be found here, and mares big with foal, and others with their colts wantonly running by their sides."

Edward II. procured draught horses from Flanders, and cavalry horses from Spain and Italy; and considerably improved the English breeds. In several succeeding reigns, public ordinances were promulged, and many private enterprises conducted, for improving the breeds; and in the reigns of Henry VII. and the three succeeding monarchs, in particular, stallions were imported from Spain and Barbary, to improve the beauty, spirit, and fleetness of the breeds, and from Denmark and the Netherlands, to improve their strength and size. In the reign of Henry VIII., either Barbary horses, or descendants from them, were expressly used for racing, and the system was commenced of promoting the characteristics which are technically designated blood. In the reign of Elizabeth, horses were first used for drawing coaches; and they speedily became so highly appreciated for this purpose, and were so rapidly bought up, and rose to so enormous a price, that a question was raised in parliament whether the use of coaches should not be restricted to the higher classes. "This fashion," remarks Youatt, "would have produced an injurious effect on the character of the English horse; it would have too much encouraged the breed of the heavy and slow horse, to the comparative or almost total neglect of the lighter-framed and speedy one; but gunpowder having been invented, and heavy armour beginning to be disused, or at this period having fallen into almost perfect neglect, a lighter kind of horse was necessary in order to give effect to many of the manœuvres of the cavalry. Hence arose the light cavalry—light compared with the horsemen of former days—heavy compared with those of modern times; and hence, too, arose the lighter horse, which, except for a few particular purposes, gradually superseded the old heavy war and draught horse."

James I. pursued the system. begun in Henry VIII.'s time, of improving "the blood" of the best breeds; he procured from Barbary a set of remarkably fine mares, significantly known as the royal mares, and distinguished by eminent purity of breed, and peculiar excellence of form; and he made an attempt, though a totally unsuccessful and even a disparaging one, to introduce the Arabian breed. Regular race-courses were either established or improved at Garterly, Croydon, Enfield-Chase, and Stamford; and racing was practised on systematic principles and according to fixed and well-defined rules. Charles I. encouraged racing, and established the race-course of Newmarket; and even Cromwell, in spite of both his own sternness, and the austerity of his age, so far countenanced this sport as to keep a stud of race-horses. The Restoration gave a new impulse to racing, and to the improvement of the horse. The Arabian breed was reintroduced; and, after being fairly tried, began to establish its great modern celebrity. "From that time to the present, by a judicious mixture of crossings of the native and the eastern horses, in different degrees of consanguinity, according to the different purposes for which they are required, we now stand unrivalled among nations; and we now send our breeds back to eastern countries, to meliorate that 'blood' which we originally borrowed from them."

The Anatomy of the Horse.—Supposing the bones stripped of the flesh and other soft parts with which they are invested, and yet connected together, either by their own natural ligaments, or, artificially, by means of wires; in that state they constitute a *skeleton;* the study of the mechanism of which it is that lays the foundation of all our anatomy. The figure of the skeleton of a horse in *Plate XXIX.* will convey a very correct idea of the outworks of his anatomy, and at the same time enable us to fill up the outline comprehensibly, and we hope, profitably and satisfactorily, to our readers. A general view, either of the skeleton or the complete horse, will show, that the entire body, leaving out the head and neck, will come pretty correctly within the limits of a square; a configuration we shall find it useful to remember; because it will at once enable us to form tolerably correct notions concerning proportion. For example, we shall find, on dividing this square, that a horizontal line drawn through its middle will about include the *trunk* within the superior division, the limbs within the inferior; and again, a perpendicular line drawn through the middle of the square will bisect the body into two equal parts, and fall upon a plane ground surface at a point equidistant from the four points of tread. The trunk, or middle piece of the skeleton is supported by four columns, the *limbs;* which, though some of their component pieces are placed in different directions, descend in and form, in the aggregate, direct perpendiculars: they support the trunk in about an equal ratio, but the weight of the neck and head descend chiefly upon the fore limbs, in consequence of their elevation upon and junction to the anterior part of the trunk.

We divide the skeleton, in our description, into *trunk*, *head*, and *extremities*.

The TRUNK comprises the *spine*, *thorax*, and *pelvis*.

The SPINE comprehends the long chain of irregular bones extending from the head to the tail; it is the part vulgarly denominated the *backbone:* although it no more belongs to the back, exclusively, than it does to the neck, the loins, or the tail; in fact, of all these parts it constitutes the bony fabric. Its bones, whose number in all amounts to 30, are denominated *vertebræ* (from *verto*, to turn). Seven of them belong to the neck, and are thence called *cervical;* 18 to the back, and are named *dorsal;* and five to the loins, denominated *lumbar*.

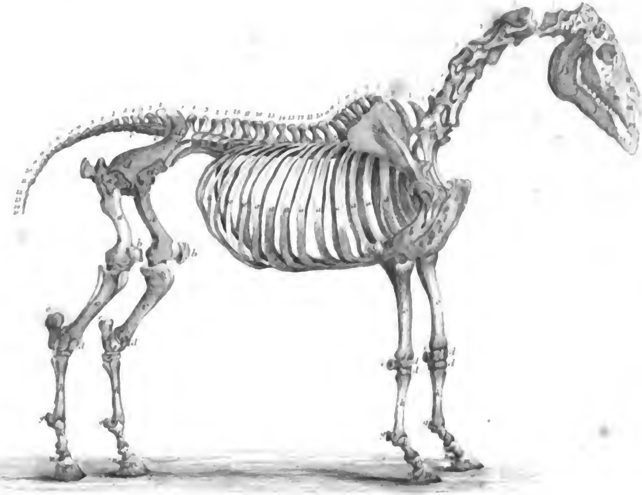
The *Cervical Vertebræ* give form and length and support to the neck. The first of them is connected with the occipital bone; (the bone forming the poll of the head;) the last is joined to the first of the dorsal vertebræ: the intervening bones are linked one with another. These vertebræ are larger and admit of more motion between them than either of the other classes; hence it is that the neck becomes a very moveable part. A horse can look, and turn his head almost directly, either to the right or to the left, and can also extensively raise or depress his head; and in almost every movement of the head, the neck participates, or rather we may say, is principally concerned in its performance.

The *Dorsal Vertebræ* give form and strength to the back. They are smaller, and have not so much freedom of motion as those of the neck, but are more numerous. They are connected one with another, with the exception of the first and last; and of them, the former is joined to the cervical, the latter to the first lumbar vertebra. They have also attached to them the heads of the ribs; which are received into the cavities formed between them.

The *Lumbar Vertebræ*, commonly *five*, occasionally *six* in number, possess an intermediate magnitude, and indeed facility of motion, between the cervical and dorsal. At the fore end they are joined to the dorsal; at the hind, to the sacral or rump-bone.

The THORAX, or *chest*, includes the cavity formed by the ribs and breast-bone.

The *ribs*, thirty-six in number, form so many parallel bony arches, corresponding in number and form on either side, running from the spine, superiorly, to the breast-bone, which is situated, in relation to them, anteriorly and inferiorly. They form a cavity spacious in proportion to the circularity and depth of their arches, within which are contained



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The English Cart Horse

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organs most important; and it is to form this cavity and serve to protect the contents of it, that these bones are useful.

The **Pelvis** is the hinder part of the trunk; it constitutes the osseous basis of the rump, the hips, and the tail. It is composed of eighteen bones, viz. the two hip or haunch bones; the rump-bone; and the fifteen small bones of the tail.

The *Hip-Bones* are the two large bones, whose prominent or uppermost parts form the hips; while their inferior parts are embedded in the haunches. They are the largest pair of bones in the skeleton: in the joint the butchers call "an edge-bone of beef," one of these is the bone presented to us. It lies upon, and is fastened to, the lateral parts of the rump-bone; and, inferiorly, has connected to it the proper haunch-bones, to which it serves as the pivot or axis of motion.

The *Rump-Bone* is joined to the spine, of which it looks like, and is, indeed, the natural continuation; although anatomists choose to regard it as a distinct part. It has the appearance of being composed of five pieces, and is so originally, but they become by age consolidated. It possesses no motion within itself.

The *Coccygeal* or *Tail Bones*, are continued from the posterior end of the rump-bone; which they very much resemble, only that they are smaller, and that they continue, still, to diminish from first to last. They vary in number from 13 to 18, in different horses. They admit, altogether, of great variety and extent of motion, which accounts for the multiplicity and facility of movements possessed by the tail.

The **Head**, the part we shall next consider, presents a quadrilateral bulky form, broad and flattened on the sides, narrow and contracted towards the nose, and for the most part hollow interiorly. It is remarkable for the prolongation and capaciousness of the parts forming the nose and mouth, and for the contractedness of the cavity for holding the brain. It constitutes the anteriormost part of the skeleton; is articulated with the spine, from which it is suspended; and, for the sake of description, is divided into *cranium* and *face*.

The **Cranium** or *skull*, is, more plainly speaking, the *brain-case*, being the part exclusively devoted to the lodgment of the brain. It constitutes the postero-superior parts of the head; is prominent and convex, superiorly and laterally; hollow and vaulted, interiorly. It is composed of ten separate bones or pieces; three in pairs, the others single; viz. one pair of frontal bones, one parietal bone, two pairs of temporal bones, one occipital, one ethmoid, and one sphenoid bone.

The **Frontal Bones** form the antero-superior part of the cranium, the part we denominate the forehead, and which, in the living horse, is very commonly marked with a patch of white hair, called a star. This bone is worthy of remark, from the circumstances of its supporting, internally, the anterior lobe of the brain, and of having two excavations within it, which take the name of the *Frontal Sinuses*.

The **Parietal** is the bone joined to the posterior side of the frontal. It encases the middle lobes of the brain.

The **Temporal Bones**, four in number, form the sides of the brain-case. One pair of them are called the *squamous*, because their borders overlap those of the parietal bone, after the manner of a scale; the other, from their hardness, the *petrous portions:* these latter contain the internal organs of hearing, and to them the ears are attached.

The **Ethmoid** and **Sphenoid Bones** form what is denominated the *base* of the cranium; the part upon which the brain rests, and to which, anteriorly, are united the bones composing the posterior parts of the face. The former is remarkable for possessing a structure very like a honey-comb, which communicates with the nose; and the latter has two sinuses within it, which also open into the nasal cavities.

The **Bones** of the **Face**.—The face constitutes the antero-superior, anterior, and inferior parts of the head, making altogether (including the lower jaw), about four-fifths of the whole; it is the part to which the head owes its prolongation, anteriorly; and its breadth and capacity, inferiorly. It is constituted of two perfectly distinct and separate parts: —The *upper* and *lower jaws*.

The *Upper Jaw* is composed of seventeen pieces or separate bones, which are joined, immoveably, one to another, after the same manner as the component pieces of the cranium. They are all in pairs with the exception of one: and their names are, the nasal bones; the superior and anterior maxillary bones; the malar; the lachrymal; the palatine; the superior and inferior turbinated bones; and the vomer, which is single.

Our limits will not permit us to particularize these bones, nor indeed is it necessary for the purpose we have in view; we shall, therefore, confine ourselves to a few general remarks on the upper jaw, considered as an integral structure. The first objects which appear to strike us, are the *orbits*, the cavities designed for the lodgment of the eyes. They are formed by the union of four of the bones of the cranium, and three of those of the face. They are conical in their conformation, their bases being the openings through which the eyes look, and their direction is such that the most extensive sphere of vision is obtained.

The *Anterior Nasal Aperture* is the large vacuity presented in the anterior and inferior part of the head; around which, in the living animal, the nostrils are attached. It opens into an extensive cavity, divided into two by a middle (gristly) partition; which apartments have free communication with the sinuses on their correspondent sides; and it is the number, capacity, and extent of surface altogether of these nasal cavities that endow the animal with his exquisite sense of smell.

The *Mouth* is the space formed between the upper and lower jaws, varying in capacity according to the degree of their separation.

The *Lower Jaw* consists of a single bone. It is connected with the upper by two joints existing between the temporal bones and its condyloid eminences, by which it possesses very free motion downwards and backwards, and also some degree of lateral motion.

The *Teeth* are common to both jaws. They are the instruments used by the animal for the abscission and manducation of his food. There are three kinds or *classes* of teeth: the *nippers*, or incisive teeth, 12 in number, which are placed in two semicircular rows in front of the jaws; the *grinders*, or molar teeth, 24 in number, which are implanted in four longitudinal rows into the sides of the jaws; and the *tusks*, or canine teeth, 4 in number, which are placed in the middle of the lateral interspaces between the nippers and grinders, making altogether 40 teeth.

The **Extremities** are four in number, and are disposed in pairs, viz. two *fore* and two *hind*.

The **Four Extremities** are placed against the sides of the anterior parts of the trunk; from which they proceed downward. Each of them is divided into shoulder, arm, knee, leg, pastern, coronet, and foot.

The *Shoulder* is constituted of two bones; the blade bone, and the humeral bone: the former is broad, and flat, and thin, and is somewhat excavated internally, in order that it may lie in adaptation against the ribs; the latter is a cylindrical bone, and forms a ball and socket joint, superiorly and anteriorly, with the blade bone, and a hinge joint, inferiorly and posteriorly, with the arm bone.

The *Arm* consists, in the adult horse, of a single bone; but in the colt, the arm bone is separable into two. Below, it forms a joint with the knee.

The *Knee* is composed of seven small cubiform bones; six of which are placed so as to form two rows or tiers, one above the other; the seventh is placed behind the others.

The *first row* consists of the scaphoid bone on the inner side; the cuneiform, on the outer; and the lunar bone in the middle. The *lower row*, of the trapezoid bone, under the scaphoid; of the magnum, or large bone, under the lunar; and of the unciform, under the cuneiform. The seventh bone, the trapezium, is connected with the cuneiform. The superior row articulates with the arm bone; the inferior row rests upon the cannon and splint bones.

The *Leg* is composed of three bones; the cannon, and the two splint bones. The cannon (also called the large metacarpal) is a straight cylindrical bone, about the same length as the arm bone, reaching from the knee down to the pastern, where it articulates with the pastern bone. The splint bones (also denominated the small metacarpal) are two slender pieces attached to the back of the cannon; they aid in the support of the bones of the knee, but do not reach to the pastern, themselves being sustained by the gristly substances which connect them to the cannon.

The *Pastern* consists of the pastern bone alone; a short bone compared to the cannon, which it otherwise resembles in form. With the cannon, it forms the fetlock joint; with the coronet bone, the pastern joint.

The *Coronet* has for its base the coronet bone; and is, only that it is shorter and somewhat broader, in form exactly that of the pastern bone. It articulates below with the coffin and navicular bones, and thereby forms the coffin joint.

The *foot* is composed of two bones; the coffin and navicular. The coffin bone is the large one, and has the general shape of the hoof which contains it. It is a very porous and even a brittle bone, and, were it not for its elastic attachments to the hoof, would be quite inadequate to the support of the superincumbent weight. The navicular or shuttle bone, may be regarded as an appendix to the coffin, to the posterior part of which it is attached. Its principal uses appear to be, to serve as a spring to the foot, and to enable the flexor muscles to act with more effect.

The Hind Extremities are connected with the posterior parts of the trunk, which they support. Each limb is divided into haunch, thigh, hock, leg, pastern, coronet, and foot.

The *Haunch* has for its base, inferiorly, the round bone, which is one of the strongest bones in the body. It is cylindrical in form; only possessing, superiorly, a spherical head, which forms a ball and socket joint with the hip bone; also two prominences inferiorly, which form a double hinge joint with the thigh bone. The prominence of this joint, in front, known as the *stifle*, is completed by the stifle bone, which is attached by muscles to the round bone, and by ligaments to the thigh bone

The *Thigh* is formed by the thigh bone, which in the adult animal is all one; but in the young subject consists of a large bone and a small one, attached to its outer side, very much like a splint bone; the connexion between them being of a gristly nature. The lower end of this bone has a pulley-like connexion with the uppermost bone of the hock; and in this structure it is, that the motion of the hock joint principally resides.

The *Hock*, like the knee, to which it corresponds, consists, not of one or two, but of many small bones—of six: and their names are, the knuckle bone; the hock bone; the cuboid bone; and the large, middle, and small cuneiform bones.

The knuckle bone is the uppermost one; that which presents a pulley-like surface upon which plays the thigh bone. The hock bone is the one which projects behind, forming what is denominated *the point* of the hock; to it the ham-strings are fixed. The cuboid bone forms the outer part of the hock. The three cuneiform bones, all broad and flat, with a circular outline, are placed, one upon the other, between the knuckle and the cannon bone.

The bones below the hock, composing the *hind* leg, pastern, coronet, and foot, are exactly the same, in regard to number and all particularities, as those composing the *fore* leg, pastern, &c., at least, there is only this material difference—that the hind cannon bone is about one-sixth of its length longer than the fore one.

EXPLANATION OF *PLATE XXIX.*

The entire skeleton is divided into Trunk, Head, and Extremities.

The Trunk comprises the spine, the thorax, and the pelvis.

The Spine includes the long chain of bones extending from the head to the tail.

The Neck is composed of seven cervical vertebræ, numbered from 1 to 7.

The Back is composed of eighteen dorsal vertebræ, numbered from 1 to 18.

The Loins are composed of five lumbar vertebræ, numbered from 1 to 5.

The Tail is composed of fifteen pieces (very like vertebræ), numbered from 1 to 15.

The Thorax, formed by the ribs *a, a, a, a*, and the *Sternum* or *Breastbone, b, b, b.*

The Pelvis, formed by the *Sacrum* or *Rump-bone, c, c, c, c, c;* the two hip-bones, *d, d;* and the *Coccyx* or *Tail.*

The Head, the second division of the skeleton, comprehends the cranium and the face.

The Cranium, Skull, or brain-case, is composed of ten bones, or separable pieces; six of which are visible in the Plate, viz. the frontal, *f, f*, the parietal, *p, p*, the temporal, *t, t*, and the occipital, *o, o.*

The Face is composed of seventeen bones; of which may be seen in the Plate—the nasal bones, *n, n;* the superior maxillary, M, M; the anterior maxillary, *m, m;* the malar, *r, r;* the lachrymal, *l, l;* and inferior maxillary bone, or lower jaw, J, J. Also the teeth.

The Extremities are, two *fore* and two *hind.*

The Fore Extremity comprises the shoulder, composed of the scapula or blade-bone, *a, a;* and the humerus *b, b;* the arm-bone, *c, c;* the six bones of the knee, *d, d;* the seventh, behind the others, *e;* the cannon, or metacarpal bone, *h, h;* the sesamoids, *g, g;* the pastern bone, *k, k;* the coronet bone, *o, o;* the coffin, *m, m;* and the navicular bone, *n, n.*

The Hind Extremity comprises—the haunch, composed of the femoral or haunch bone, *a, a;* and the patella, or stifle bone, *b, b;*—the thigh, formed by the tibia, the veritable thigh-bone of the horse, *c, c;*—the hock *d, d;* consisting of six small bones; the os calcis, or hock-bone, projecting behind, *e, e;* and the leg, and parts below, which are the same as those of the fore extremity.

Foreign Breeds of Horses.—The Arabian horse is considerably smaller than the English race-horse; but combines the utmost fieriness and spirit with tractableness and good temper. Its head has an admirable shape and contour; its limbs are perfectly symmetrical; and its characteristic properties are so distinct and persistent as to be readily discernible in every one of almost numberless sub-breeds. "The Bedouins," says Burckhardt, "count five noble breeds of horses, descended, as they say, from the five favourite mares of their prophet, — Taueyse, Manekeye, Koheyl, Saklawye, and Dujlfe. These five principal races diverge into infinite ramifications. Every mare particularly swift and handsome, belonging to any one of these five chief races, may give origin to a new breed, the descendants of which are called after her; so that the names of different Arab breeds of the Desert are innumerable." Yet through all the varieties, the neck of every individual is long, arched, and beautifully salient from the chest, the course of the veins is elegantly apparent, the lower jaw is comparatively thin, the nostrils are wide, the muzzle is short and fine, the eye is prominent and sparkling, the ears are small, and the forehead is broad and square. Two chief defects are the narrowness of the chest, and the lightness of the whole form. The southern parts of Arabia contain no good varieties of the Arabian horse except such as have been brought from the north; and the deserts of Syria, from the confines of Arabia as far northward as the Euphrates, contain better breeds than any which exist in Arabia itself. "I have no hesitation in saying," observes Burckhardt, "that the finest race of Arabian blood horses may be found in Syria, and that of all the Syrian districts the most excellent in this respect is the Hauran, where the horses may be purchased at first cost, and chosen among the camps of the Arabs themselves, who occupy the plains in spring time. The horses brought up at Basra for the Indian market are purchased at second hand from Bedouin dealers; and an Arab will rarely condescend to offer a good horse at a distant market without a certainty of selling it. It might perhaps be advisable for the great European powers to have persons, properly qualified, employed in purchasing horses for them in Syria, as the best mode of crossing and ennobling their own studs. Damascus would be the best position for the establishment of such persons. I am induced to suspect that very few true Arabian horses, of the best breeds, and still less any of the first rate among them, have ever been imported into England, although horses of Syria, Barbary, and Egypt, have passed under the name of Arabs." Two quite distinct races besides the Arab occur in Syria,—the Toorkoman and the Kourdy; yet the former are said to have descended from Arabian sires, and the latter are an established cross between the Toorkoman and the Arabian.

The Barbary horse, or most select horse of the Moors of the north-western parts of Africa, so celebrated for its speed and for the spiritedness and nobleness of its action, and so liable to be confounded by careless or ignorant observers with the Arabian horse, is noticed in the article Barb.

The Persian horse ranks next to the Arabian for combined beauty and spirit. It is larger than the Arabian, has a fine forehead, is symmetrical, light, and sprightly, and presents to cursory observation a nobler appearance than the Arabian, but is far inferior in disclosing minute beauties to close examination. Berenger, who saw the Persian horses in a state of beauty, docility, speed, and wonderful power of endurance, somewhat greater than they now possess, says, "They are in general small-headed; they have long and somewhat too fine foreheads, and they are rather too narrow-chested; their legs are a little small, but their croups are well fashioned, and their hoofs good and firm; they are docile, quick, light, bold, full of spirit, capable of enduring much fatigue, swift, sure-footed, hardy in constitution, and contented with almost any provender." These animals are remarkably pugnacious; and possess a constant and indomitable love of fight both in the stable and the field. "Their keepers," says Sir R. Kerr Porter, "always sleep on their rugs amongst them to prevent accident; and sometimes, notwithstanding all this care," and that of tieing up their heads with double ropes and fettering their heels to fastenings in the ground, "they manage to break loose, and then the combat ensues. A general neighing, screaming, kicking, and snorting soon rouses the grooms, and the scene for a while is terrible. Indeed no one can conceive the sudden uproar of such a moment who has not been in eastern countries to hear it; and then all who have must bear me witness that the noise is tremendous. They seize, bite, and kick each other with the most determined fury, and frequently cannot be separated before their heads and haunches stream with blood. Even in skirmishes with the natives, the horses take part in the fray, tearing each other with their teeth, while their masters are in similar close quarters on their backs." The best varieties of the Persian horse, for both strength and elegance, occur in Kurdistan.

The Toorkoman or Toorkmun horse belongs to the portion of South Tartary north-east of the Caspian Sea; and is said to have descended from Arabian sires; and has been pronounced by good judges a better war-horse than even the pure Persian. Sir R. Kerr Porter describes it as too small in the barrel, too long in the legs, comparatively large in the head, and often ewed and too long in the neck; and Sir Alexander Burnes says, "The Toorkmun horse is a large and bony animal, more remarkable for strength and bottom than symmetry and beauty. Its crest is nobly erect; but the length of body detracts from its appearance in the eye of a European; nor is its head so small nor its coat so sleek as the brood of Arabia. This want of ornament is amply compensated by its more substantial virtues; and its utility is its beauty. The breed of Toorkmun horse is of the purest kind. When the animal is over-heated, or has performed any great work, nature bursts a vein for it in the neck; which I did not at first credit, till I had become an eye-witness of the fact. The Toorkmuns cut their horses; and it is a popular belief among them, that they are then more alert and undergo greater fatigue than stallions." A Toorkmun horse has been known to carry a rider 500 miles in six days; and many an individual of the breed is supposed to be capable of carrying a rider an hundred miles a-day, on two or even three successive days. A cross between the Toorkmun horse and the pure Persian, produces a most magnificent looking animal.

The Turkish horse is a mixed offspring from the Arabian and the Persian breeds, and from some kindred varieties. It is as gentle and tractable as the Arabian, but neither so fleet nor so vigorous. Busbequius, who went as ambassador to Constantinople in the 17th century, says, "There is no creature so gentle as a Turkish horse, nor more respectful to his master, or the groom that dresses him. The reason is, because they treat their horses with great lenity. The countrymen in Pontus stroke them, bring them into their houses, and almost to their tables, and use them even like children; and the grooms frequently sleek them down with their hands, and never use a cudgel to bang their sides but in cases of necessity. This makes their horses great lovers of mankind; and they are so far from kicking, wincing, or growing untractable by this gentle usage, that you will hardly find an ill-tempered horse amongst them." The Turkish horse takes rank with the Arabian and the Barb as a contributor to the improvement of the English horse.

The Circassian horse is inferior to both the Persian and the Toorkmun, and possesses some little affinity to the wild breeds of Tartary; yet it boasts some points of great value, and excels many approved varieties of the horse in both strength and speed, and is bred and managed with eminent care. The sub-breeds of it are exceedingly numerous; and each belongs to a tribe or other limited community, and is distinguished by a peculiar artificial mark, the counterfeiting of which is punishable with death.

The Tartarian horse has a somewhat uniform character throughout the vast territory from the western parts of Russian Tartary to the eastern parts of Chinese Tartary; and though narrow-chested, long-necked, small-bodied, meagre in the hams, stilty in the legs, and wofully lank in general appearance, it possesses some good properties for the saddle, and an astonishing capacity of endurance. "The Tartar horses," says Berenger, "although but of a moderate size, are strong, nervous, proud, full of spirit, bold, and active. They have good feet, but somewhat narrow; their heads are well-shaped and lean, but too small; the forehead long and stiff; and the legs over long. Yet with all these imperfections, they are good and serviceable horses, being unconquerable by labour, and endowed with considerable speed." The wild horses of the great herds in the elevated steppes of Tartary, when captured, tamed, and trained, often excel the domesticated horses in both strength and general serviceableness; and the home-bred horses of the Nogais Tartars are stronger and taller than the home-bred ones of other tribes,—and, in some instances, are trained to draw carriages. The owners of domesticated ones, pet and fondle them when young, and bestow the utmost care upon their discipline, and set their children very early on them, and do not themselves mount them till they are five or six years old; and then they exact from them the severest service, and inure them to almost incredible fatigue, obliging them to travel two or three days with little or no rest, or making them spend four or five days without any drink, and with no more or better food than a handful of grass.

The Indian horse is of variable character, but generally small, and possessed of considerable courage and hardihood, and bearing the marks of degeneracy from a nobler stock. "The breeds of horses indigenous to Bengal," says Williamson, "are not to be boasted of, whether for temper or other good qualities. They have generally Roman noses, and sharp narrow foreheads, much white in their eyes, ill-shaped ears, square heads, thin necks, narrow chests, shallow girths, lank bellies, cat hams, goose rumps, and switch tails. Some may occasionally be found in every respect well-shaped. They are hardy and fleet, but incapable of carrying great weights. Their vice is proverbial; yet until they arrive at four or five years, they are often very docile and gentle; and after that period, they for the most part are given to rearing, kicking, biting, and a thousand equally disagreeable habits." The sub-variety or breed called the Toorky, is the best, and though possessing some of the bad characteristic properties of all the breeds, and particularly smallness of body and length of bone below the knees, is at once handsome in shape, elegant in action, and tractable in disposition. The Tauzee or Tazee breed, is a somewhat good kind, yet is slight in form, concave in the back, deficient in strength, and irritable and sullen in temper; and it occurs, not only in Hindostan, but between the Hydaspes and the Indus, and in the Affghan provinces of Bunnoo and Damaun. The Iranee breed is second only to the Toorky; and has clean limbs, well-knit joints, strong quarters, large head, and pendulous ears. An Indian pony called the Tattoo, and varying in height from 10 to 12 hands, is a hardy and serviceable beast of burden; and an Affghan pony, called the Yauboo, is very strong, and very useful, and carries a great load, but has not so much power of endurance as the mule.

The Egyptian horse possesses much infusion of Arabian blood, and has often been imported into Britain under the name of the Arabian horse. It is seldom more and often less than 14 hands high; its forehead is as broad as that of the thorough-bred English horse, but loses its effect upon the observer in consequence of greater elongation of the nose; its barrel is round and well-ribbed; its croup, in many instances, deflects from the horizontal; and its fore-legs occupy the position which the English jockeys technically call 'standing over.' "The Egyptian horse," says Burckhardt, "is ugly, of coarse shape, and looking more like a cart-horse than a racer. Thin legs and knees, and short and thick necks, are frequent defects among them. The head is sometimes fine; but I never saw good legs in an Egyptian horse. They are not able to bear very great fatigue; but when well fed, their action occasionally is more brilliant than that of the Arabian. Their impetuosity, however, renders them peculiarly desirable for heavy cavalry; and it is upon this quality alone that their celebrity has ever been founded." The prevailing colours are grey and chestnut.

The Nubian or Dongola horse occurs in the country which lies between Egypt and Abyssinia. Its height is seldom less than 16 hands; its neck is slender and finely poised; its crest is beautifully shaped; its withers are high; its chest is narrow and deficient in depth; its legs are long and slender; and its flank and quarters are deficient in bulk. "The Nubian horses," says Bruce, "are the breed which was introduced here at the Saracen conquest, and have been preserved unmixed to this day. What figure they would make in point of fleetness, is very doubtful, their make being so entirely different from that of the Arabian; but if beautiful and symmetrical parts, great size and strength, the most agile, nervous, and elastic movements, great endurance of fatigue, docility of temper, and seeming great attachment to man beyond any other domestic animal, can promise anything for a stallion, the Nubian is above all comparison the most eligible in the world. The horses of Halfaia and Gerri do not arrive at the size of those in Dongola. They are black and white, but a vast proportion of the former to the latter. I never saw the colour we call grey, that is, dappled, but there are some bright bays, or inclining to sorrel." Some Nubian horses have recently been brought to Britain.

The Abyssinian horse is, in general, strong, well-shaped, active, and spirited. Its prevailing colour is black. The Abyssinians use it only for war and hunting; and they are attentive to it, and keep it in good condition. Their works of fatigue, drudgery, and long travel, are performed by mules. The horse is found in Ajan and Adel, on the southern border of Abyssinia; but is scarcely ever seen, or but very seldom seen, throughout the vast tracts of country extending thence, along the whole eastern coast of Africa, to the vicinity of the Cape of Good Hope.

The South African horse is the mongrel offspring of individuals of widely different breeds, introduced by the Dutch colonists, to the Cape of Good Hope, from Persia, South America, Java, and Batavia. It is seldom above 14 hands high; and is hardy, and possesses great power of endurance; but it is naturally vicious; and even after being carefully and perseveringly disciplined, it becomes cross and intractable when pushed beyond its usual pace. Sufficient supplies of it for mounting a whole regiment of light dragoons, have repeatedly been furnished to troops on their way to India.

The horse of the Pampas, or wild horse of South America, considerably resembles the Spanish horse, from which it has descended; it is often caught for the uses of man, and is easily tamed and disciplined, and speedily acquires an extraordinary and very sagacious subordination; it possesses great powers of endurance; and, when ridden in a peculiar but somewhat cruel fashion, it carries a rider 60 or 70 miles without rest or pause, or journeys upwards of 100 miles at the speed of 12 miles in the hour. The capturing of the wild horse with the lasso—a strong plaited thong, half an inch thick, 40 feet long, slippery with grease, and having a running noose at the end—is performed by a well-mounted Gaucho, careering at full speed on the outskirts of a herd, and practising great dexterity and skill of action. "The lasso," says Basil Hall, "is thrown round the two hind legs, and as the Gaucho rides a little on one side, the jerk pulls the entangled horse's feet laterally, so as to throw him on his side, without endangering his knees or his face. Before the horse can recover the shock, the rider dismounts, and snatching his poncho, or cloak from his shoulders, wraps it round the prostrate animal's head. He then forces into his mouth one of the powerful bridles of the country, straps a saddle on his back, and bestriding him, removes the poncho; upon which the astonished horse springs on his legs, and endeavours by a thousand vain efforts to disencumber himself of his new master, who sits quite composedly on his back, and, by a discipline which never fails, reduces the horse to such complete obedience, that he is soon trained to lend his whole speed and strength to the capture of his companions." The horse of the Pampas, in both its native and its tamed state, resembles the Arabian in having no intermediate pace between a walk and a gallop.

The horses of the mountains of Venezuela are a singular-looking breed, of very diminutive size, and have the appearance, not of ponies, but of miniature cart-horses. "They have large shaggy manes, very rough coats, and thick fetlocks, covered with long hair. They are never shod, nor are their hoofs ever pared, so that the horny part projects forwards, in some instances, to nearly a foot in length. This gives the animal a most awkward appearance, and suggests the idea of people walking with snow shoes; yet, notwithstanding this apparent incumbrance, they are very sure-footed little animals, and considered equal to mules on bad rocky roads."

The horse of the Mexican prairies has the same general ancestry as the horse of the Pampas; and possesses similar properties to it, both in a wild and in a domesticated state. It has a fine, delicate head, wide nostrils, slender, tapering, clean limbs, small, hard hoofs, and a symmetry of form resembling that of the Arabian. It occurs wild, in large troops, not only in the savannahs and woods of Mexico, but so far north as the Rocky Mountains, and the sources of the Columbia; and it is captured and disciplined by the North American Indians; but is less carefully managed, and possesses less valuable properties, in its domesticated state, than the horse of the Pampas. The Osages, in particular, form large hunting parties for chasing and capturing it, in its most northern haunts; and, when in pursuit of it, they use relays of fresh hunting-horses till they have run down a wild herd.

The Canadian horse is supposed to be a descendant of the domesticated French horse; and it occurs, not only throughout all the older parts of Canada, but in the northern parts of the United States. It is comparatively small in size; but is strong, hardy, patient, capable of great endurance, and a proficient in the pace of trotting. It will work, amid the intense frosts of the Canadian winter, till it foam with sweat; and will then stand for hours, exposed to the intense frost, without sustaining injury; and will then, when fretted over with ice and icicles, good-naturedly resume its labours.

The horses of the United States of America exhibit great variety, and belong to many different breeds and crosses. A long-legged, light-bodied animal, called the Conestoga horse, sometimes 17 hands high, occurs in some of the Middle States, and is used chiefly for the carriage; the Mexican and Canadian breeds occur in some places of respectively the west and the north; the high-bred English horse occurs in almost all the older States, particularly Virginia and Kentucky; and some of the most improved breeds of Europe have recently been introduced. Almost all the good kinds of horses in the United States are hardier and less subject to disease than the corresponding kinds in Europe; and even the direct and pure-bred descendants of pure European breeds are hardier than their ancestors, and probably might strengthen the constitutions of their kindred if they were introduced back to Europe. "In most parts of North America," says Mr. Winter, "fast trotting horses are esteemed above all others. It is the prevalent and fashionable method of testing the power of their horses; and certainly appears well-calculated to establish properties highly useful to the community. The more rapid pace of the gallop is rejected for the more useful one of the trot. The most remarkable trotters that have ever appeared in England were brought from the United States; amongst them may be instanced Tom Thumb, Rattler, Rochester, and Confidence. The Americans properly attack our system of turf-breeding: they say we go for speed, surpassing speed; and having aimed at this alone for half a century, and still continuing the practice, it will not be surprising if we lose everything else that is valuable."

The Spanish horse was originally the same as the Barb; and it acquired its distinct properties simply from difference of climate and of treatment; and it long possessed a celebrity second only to that of the real Barb and of the Arabian. "The neck," says Berenger, "is long and arched, perhaps somewhat thick, but clothed with a full and flowing mane; the head may be a little too coarse; the ears long, but well-placed; the eyes large, bold, and full of fire; their carriage lofty, proud, and noble; the breast large; the shoulders sometimes thick; the belly frequently too full and swelling, and the loin a little too low; but the ribs round, and the croup round and full, and the legs well formed and clear of hair, and the sinews at a distance from the bone; active and ready in their paces; of quick apprehension; a memory singularly faithful; obedient to the utmost proof; docile and affectionate to man; yet full of spirit and courage." The most valued kinds of the Spanish horse occur in Andalusia; and those next in esteem occur in Estremadura and Granada. But the climate of the greater part of Spain seems to be highly favourable to the breed; and near Aranjuez are a suite of royal stables of mares, for the purpose of maintaining the breed in the highest excellence.

The Limousin horse is the most high-bred of the numerous breeds of France; and is used principally for the saddle. This animal is remotely descended from the high-blooded breeds of the East, and has a considerable resemblance in both history and character to the blood-horse of England; and it came into great request, at the time when the invention of gunpowder and the revolution of European manners discarded the use of heavy armour from horsemen, and created a love for equestrian sports and the pleasures of the chase, and rendered a light, nimble, and active horse an almost necessary substitute for the powerful war-horse or strong and muscular charger. It has been highly esteemed since the 15th century; and, as it has always enjoyed a climate more favourable to the high-bred horse than even that of England, it would, if propagated, fed, and groomed with due care and assiduity, have become a better animal than the English blood-horse,—closely similar to it in characteristics, but superior in aggregate excellence.

The Norman horse is the best of the French breeds for heavy cavalry-service, and for all kinds of carriage-draught. It is large, powerful, well-tempered, sufficiently active, and admirably adapting for performing hard work on scanty fare. "I have never," says M. Hoüel, "seen such horses as the Norman ones at the collar, under the diligence, the post-carriage, the cumbrous and very heavy voiture or cabriolet for one or two horses, or the farm-cart. They are enduring and energetic beyond description; with their necks cut to the bone, they flinch not; they put forward all their efforts at the voice of the brutal driver, or at the dreaded sound of his never-ceasing whip; and they keep their condition when other horses would die of neglect and hard treatment." They are treated, from first to last, with tyranny and cruelty; they receive kicks and blows in lieu of both commands and encouragements; they are complete slaves, who dare not rebel; and yet are exceedingly gentle and docile, and so totally free from vice that a man may pass close to the heels of an hundred of them without the slightest risk of being hurt. Such of them as are free from the prevailing faults of a heavy head and too great length of limb below the hock, would form the best possible cross with a large proportion of the draught horses of Britain.

The predominant French horse is the offspring of a mixture of the Norman and other indigenous breeds with the English and the Arabian horses among the lighter kinds, and the Lancashire and other large, slow, powerful draught horses among the heavier kinds. Its general characters are somewhat large and bony head, penpulous lips, broad chest, round barrel, muscular arms, angular hocks, and upright or mule-like feet.—The Vadicasse horse, in the valley of the Meuse, has a height of 14 or 15 hands, a large head, strong, hairy limbs, and generally a roan colour; and, though inferior to the breeds and varieties in many other parts of France, is in considerable demand in the Paris market.—The Lingone horse, in the valley of the Marne, is smaller than the preceding, and has a large head, pendent ears, and a sloping croup; but, in consequence of feeling quite at home on rough and stony ground, is in large request for travelling among the mountains.—The Barrois horse, in the valley of the Aube, is a mere shelty or mountain pony, too small for the draught, but well adapted, by agility, hardiness, and good temper, for the same purposes as the Lingone horse or the Shetland pony.

The Flemish or Dutch horse is a large, powerful, and finely shaped animal; it possesses more interest than any other foreign breed to the British farmer and the British carter or waggoner; it was the main source in which all the good kinds of British heavy draught horses originated; and it still constitutes the chief means of improving our breeds of cart and waggon horses by crossing. The Flemish horse, in fact, sustains nearly the same relation to the British cart-horse, which the Arabian sustains to the British race-horse. "As the racer," says Youatt, "is principally or purely of Eastern origin; so has the English draught-horse sprung chiefly from Flemish blood; and to that blood the agriculturist has recourse for the perfection of the breed. All our heavy draught-horses, and some even of the lighter kind, have been lately much crossed by the Flanders breed, and with evident improvement. Little has been lost in depth and bulk of carcase; but the forehead has been raised, the legs have been flattened and deepened, and very much has been gained in activity. The slow heavy black, with his 2½ miles an hour, has been changed into a lighter but yet exceedingly powerful horse, that will step 4 miles in the same time with perfect ease, and has considerably more endurance." Mr. Burke, however, strikes a widely different key in reference to the Flemish horse; and, for the sake of impartiality, we must quote what he says. "There is one point," remarks he, "to which I should wish to draw attention, since I believe it is one which for some years past has tended not a little to reduce the superiority of our breed of cart-horses, and has moreover been lauded by some veterinary practitioners, receiving from them that degree of authority which sanctions the farmer in continuing a practice not altogether, in my opinion, to be recommended. I allude to crossing our breed of cart mares with the cumbersome, ill-proportioned, and slow Flemish stallions that are yearly imported into this country, and the best of which may be seen perambulating the streets of London in the drays of certain brewers, who approve of their general appearance. I have many times noticed these horses, and can safely aver, not only that I never yet saw a really well formed one, but that they are decidedly the very worst breed of draught horses I ever beheld. I never yet saw one whose feet were not flat, and whose fore legs, below the knee, were not of the worst description; the tendons at the back of the joint tied in, and the whole shank utterly disproportioned to the bulk of the horse. Indeed there is scarcely one in twenty whose legs can do much more than support his unwieldy carcase; and were it not for the large crests and heavy necks of these horses, —points which some people imagine confer a stately appearance on them, — there would be very few imported into this country. However, as many farmers are induced to make use of the first showy-looking stallion that is brought to them, I would warn them against putting any of their mares to these brutes. Few people can mistake the breed when they have once noticed it; and lest they should never have met with it, a Flemish stallion may be recognised by being mare-headed—heavy to excess in the neck and crest—flat-sided, and weak in the joints, quarters, and legs. With all these defects, or most of them, his long mane, his bulk (for he is prone to fatten), and his *tout ensemble*, coupled with a few flaunting ribbons about the head, and a gay bridle, do not fail to entrap the man who is unable to form a correct opinion of his principal points—the only true method of judging of a horse. We possess better cart-stallions than any other nation; but did we require a cross, I should say, from what I have seen, that the light Norman cart-stallion is an animal greatly to be preferred to the ponderous, inactive specimens that I have seen of the Flemish breed."

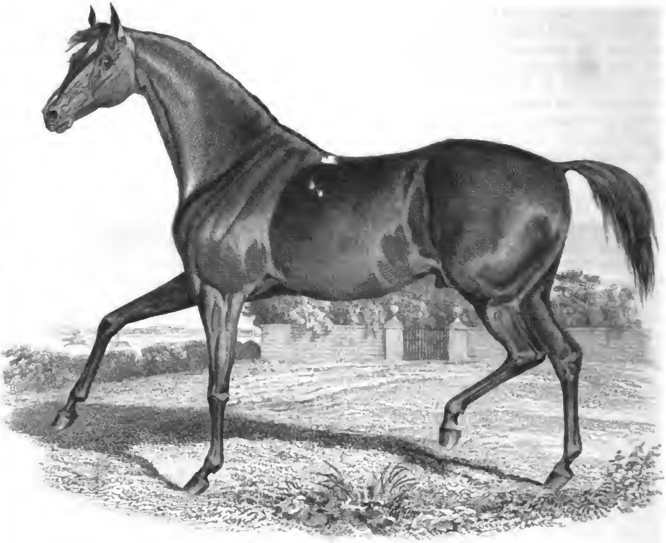
The Hanoverian horse is an animal of widely different character from the Flemish; and is used principally for purposes of aristocratic pageantry and state parade. It is one of the most celebrated of creatures for mere beauty; and has long been the peculiar property of the royal family of Hanover; and has, for several reigns past, been brought over to Britain to draw the royal carriages on occasions of public display. It is muscular, rotund, and imposing; its mane and tail are long; and its limbs are so peculiarly formed as to have much knee action. Some individuals of it are cream-coloured; some are milk-white; and some are albinoes, with blood-red pupils to their eyes.

The Danish horse is a very large and powerful animal; and is adapted, by slight variations in breeding, to almost all the purposes for which horses of any kind are used. A large stud has long been kept on the island of Alsen, selected with the nicest judgment from the best thorough-bred horses of England; and while the stallions of this stud produce from the mares of it a race of pure-blooded horses for the uses of the aristocracy, they are also allowed to cross with the mares of the surrounding agricultural population for all the ordinary purposes of the saddle and the yoke. The improvement in the horses of Sleswick and Holstein, as well as in Mecklenburg, and some of the adjoining districts, has, in consequence, been very rapid and exceedingly great. The present horses of Holstein and Mecklenburg usually stand from 16 to 18 hands high; and, though they have the defects of a ponderous form, heavy shoulders, a very thick neck, an unduly long back, and a comparatively narrow croup, they present a noble appearance, and have a lofty and imposing action, and display great strength and spirit.

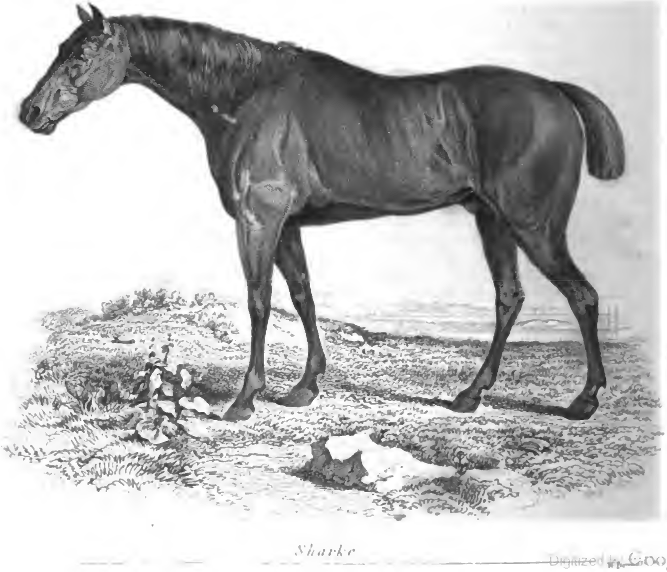
The Swedish horse is small, active, obedient, and serviceable. It has a medium appearance between a mere pony and an ordinary coach-horse; and, when posting along the public road, it proceeds with surprising speed, and often maintains a constant gallop from one post-house to another. It feeds chiefly on rye and oatmeal bread in winter, and is turned into the forests in summer. The Finnish horse is somewhat smaller than the true Swede,—seldom if ever more than 12 hands high; and it is finely formed, and has a very rapid pace. It spends a great part of its time in the forest, and has much of the habits of a wild animal; yet it is easily caught when wanted, and acts with docility and subjection. Its rate of trotting is often 12 miles an hour.

The horses of Norway, Lapland, Iceland, and Feroe all possess some degree of resemblance to the Finnish and Swedish horses, and are well adapted to the uses of their several countries. The Norway horse is larger than the Swede, but hardy, tractable, accommodating, and ever ready to give battle to a wolf. The Lapland horse is small, nimble, obedient, and sometimes impetuous; but is employed only in winter, and chiefly for drawing sledges. The Iceland horse is small, strong, and fleet; and though a few individuals are kept in the stable, the great majority live constantly in the mountains or pastoral wastes, and seek out for themselves morsels of food by scraping away the snow or breaking the ice. "The Feroe horses," says Berenger, "are small of growth, but strong, swift, and sure of foot, going over the roughest places with such certainty that a man may more surely rely upon them than trust to his own feet. In Suderoe, one of the Feroe Islands, they have a lighter and swifter breed than in any of the rest. On their backs the inhabitants pursue the sheep, which are wild in this island. The pony carries the man over places that would be otherwise inaccessible to him, follows his rider over others, enters into the full spirit of the chase, and even knocks down and holds the prey under his feet until the rider can take possession of it."

British Breeds of Horses.—The thorough-bred English race-horse has long had the reputation of being the finest variety of the horse in the world; and it has contributed fully more than any of our other breeds to acquire for Britain the fame of being the world's emporium for good horses; but it has, for some time past, been very visibly degenerating; and unless it be promptly and generally subjected to new influences of propagation and management, it threatens speedily to become inferior to several breeds, not only of the old world, but even of America. Its origin is ascribed by some writers entirely to eastern parentage, in both sire and dam; by others, to the aboriginal horse of England, slowly and elaborately improved by crossing with the best eastern breeds, particularly the Turk, the Barb, and the Arabian; and by others—and these the most judicious—to fine foreign specimens of unknown or obscure derivation, crossed with the Barb and the Arabian, and ameliorated by the influence of our climate and the most skilful and assiduous management. The thorough-bred racer of the present day, or emphatically the English horse, is generally distinguished by a head like that of the Arabian, a tapering and



Recovery



Sharke

finely-poised neck, oblique and longish shoulders, well-bent hind-legs, full fleshy quarters, flat legs, shortish below the knee, and long and elastic pasterns. But the English race-horse of former periods, as compared in a general way to the present race-horse, had a superior fulness of form, and a richer combination of speed, stoutness, and structural powers. Sedbury, Old Partner, and other distinguished race-horses of the middle of last century, possessed compact bodies, capacious chests, fine limbs, and an admirable bearing; Mambrino, Sweetbriar, Sweet-William, and other celebrated ones of a later period than the former, had not only compact bodies and capacious chests, but strong loins, strong joints, muscular arms, and long, well-inclined, massively muscular shoulder-blades; and Sharke, Johnny Gimcrack, and other famous ones of the concluding part of last century, while they evolved the properties which indicate increased speed, did not lose any portion of those which indicate requisite strength, but had capacious chests, finely-hooped ribs, long and tolerably well-inclined shoulder-blades, massively muscular arms, withers, and quarters, large pastern-joints, and admirably adjusted hind-feet, pasterns, and back-sinews. But Muly-Moloch, Selim, Pericles, and other chief racers of the commencing part of the present century, began the series of degeneracy, and were as distinctly inferior to their predecessors as superior to their successors; and, while possessing such an elongation of the skeleton and such accompanying and dependent properties as materially increased their fleetness, they were decidedly less powerful in both structure and work than any of the great racers of the preceding sixty years, and had longer backs, heavier limbs, less muscle, smaller sinews, and sharper withers. "From that period to the present," remarks a reviewer of Hookham's Comparative View of the Form and Character of the English Racer and Saddle-Horse, "racers have lost much of their vigour and stoutness; and their structural development has been entirely promoted for one object, speed. Heavy stakes, and lowering the standard of running from heats to a single run of short distance, have been the consequences of unfortunate changes; whilst the continuance of these conditions has been the cause of perpetuating them. The result has been exceedingly unfavourable to the character of our racers and saddle-horses, producing weakness, and disposing them to coarseness. The long back, flat sides, long limbs, weak loins, delicate constitutions, and strong disposition to local and hereditary disease of the modern racer and saddle-horse, are inadequate substitutes for the short back, short limbs, capacious chests, full sides, and muscular character of the old racer and hunter. Speed and weakness are no compensation for loss of vigour and stoutness." In fact, the immoral spirit of the race-course—for immoral it is, and very deeply immoral too—has been smartly working out its own punishment, and now sometimes dooms its human victim to see his darling horse done to disablement or death by a single run of less than two miles; and—like every other propensity which sacrifices all regard for the common good to the gratification of selfishness and passion—it has spread a baneful influence over society, and even done serious damage to some of the interests of common industry.

An excellent comparative view of the state of the race-horse, just before the commencement of its degeneracy in the latter part of the last century, and the state of it in the most admired specimens of the last twenty years, is afforded by the figures of Sharke and Recovery in *Plate XXX.* "The form of Sharke," says Hookham's Comparative View, "was more advanced by art for the purpose of speed, than that of any of the preceding horses. As an artificial production intended for a special purpose the form of this horse probably could not be essentially improved. He might not be so fleet for one or even two miles as the modern racers; but for four miles, or for any greater distance, he must have beaten them. His chest was capacious in the right place; if a horizontal line had been drawn through it a little below the withers, it would have been found longer than a line passed through the largest of our modern racers. This horse's ribs were finely hooped; his shoulder blades had a good inclination, and great length; the mass of muscles on his arm and withers was considerable; his quarters, the placing of his hind feet, his large pastern joints and back sinews were all admirable. We must yet admit that, as a stallion, he had lost much of the masculine character of nature. Doubtless he acquired speed under this change, but his offspring would require to be narrowly watched by a breeder looking to the future as much as to the present." Recovery was bred in 1827, and was a celebrated winner in 1830 and 1831. He was chestnut-coloured, and stood 15 hands 2 inches high; and, as compared to the vast majority of modern racers, he had great muscular power, fine action, and a singularly elegant outline. We are told that, when an equestrian statue was resolved upon as the fittest subject for the Wellington Testimonial, and when the execution of the group was entrusted to the taste and skill of Mr. Wyatt, "he, after looking long in vain for any horse of such proportionate beauties as should be pleasing to the common eye, without offending the severe taste of the classic, declared at last that such rare qualities were only to be found united, in the shape, and symmetry of limb displayed by Recovery."

The hunting horse, or country gentleman's saddle-horse, ranks next in value and beauty to the race-horse; and partakes, or ought to partake, of his peculiar qualities to the extent, in technical language, of being from half-bred to three-fourths or even seven-eighths bred. "But," says the reviewer formerly quoted, "the degeneracy of the race-horse is an evil not alone affecting itself—it is permitted greatly to influence the character of our saddle-horses. Farmers cannot breed saddle-horses without the aid of the racer; and yet over the quality of this animal they have no control. As may be expected, the offspring displays many of the bad characteristics of the parents. Hence farmers will not largely enter into the breeding of saddle-horses; they consider it subordinate to every other business of the farm, because they have no reliance on the excellence of the racers' offspring; and they pay little attention to a matter which produces a precarious return." A prime hunter stands about 15 or 16 hands high; and has a small head, wide jaws, firm and arched crest, a lofty forehand, and a broad chest; and as compared to the racer, his shoulder should be as broad and oblique and rather thicker, his barrel rounder, his arm rather more muscular, his leg shorter, his pastern shorter and less slanting, his whole body shorter and more compact, and his action considerably higher.

The common saddle-horse may possess any character intermediate between that of a well-tempered, easy-going, and long-enduring hunter, and that of the most miserable hired road hack; yet it has normal excellencies and is really as distinct a breed as the race-horse, and constitutes, in its proper state, what is technically called the hackney. See the article HACKNEY. The farmer's saddle-horse is, in some instances, a hunter, and, in some, a hackney; but in the great majority, and with eminent propriety, it is a horse of all work,—an animal adapted equally to the saddle and to the draught. A good one stands about 15½ hands high, is stout and compact, possesses some of the blood of the race-horse, and has a thicker, lower, and less slanting shoulder than the hackney. "The little farmer," remarks Youatt, "does not want a showy, complete hackney. He should be content if he is tolerably well carried; and—if he has taken a little care in the choice of his horse,—if he has selected one with sound feet, shoulders not too thick, and legs not too much under him,—and if he keeps him in good condition, and does not scandalously overweight him, the five days' carting or harrow-work will not, to any material degree, unfit him for the saddle,—especially if the rider bears in mind the golden rule of horsemanship, always a little to feel the mouth of the animal he is upon. A farmer, and more particularly a small farmer, will prefer a mare to a gelding both for riding and driving. She will not cost him so much at first; and he will get a great deal more work out of her. There can be no doubt that taking bulk for bulk, a mare is stronger and more lasting than a gelding; and, in addition to this, the farmer has her to breed from. If he has a few useful cart-mares, and crosses them with a well knit, half-bred horse, he will certainly have colts useful for every purpose of agriculture, and some of them sufficiently light for the van, post-chaise, or coach. If he has a superior mare, one of the old Cleveland breed, and puts her to a bony three-fourths bred horse, or, if he can find one stout and compact enough, a seven-eighths or a thorough-bred one, he will have a fair chance to rear a colt that will amply repay him as a hunter or carriage-horse."

The Cleveland Bay horse has a middle character between the saddle-horse and the heavy draught-horse; and constitutes a well-defined and much esteemed variety of coach-horse. It is named from the fertile district of Cleveland, on the banks of the Tees, in the North Riding of Yorkshire; but it is bred throughout the greater part of all Yorkshire and Durham. It was formed by the progressive crossing of the race-horse with the native breed of the district; and it came first into prominent notice about the middle of last century. It has an arched crest and high action; and is far superior to the old heavy coach-horse for the carriage, and considerably superior to the Clydesdale horse and the old English black horse for the lighter kinds of slow draught. But, in the aggregate character of the individuals of the breed, it is now a much lighter animal than it was in the days of its early celebrity; for it has been crossed in greater proportion than before with the race-horse, and has in consequence receded farther from the properties suitable for slow draught, and become more eminently adapted for the precise purposes of a coach-horse. The prevailing comparative lightness of its form in the present day, has given occasion to a general opinion that the Cleveland Bay, regarded as a distinct breed, has degenerated. The old Cleveland has been known to perform a journey of 60 miles 4 times in the week, completing each journey in a day, and carrying a weight of upwards of 700 lbs.

The common coach-horse of Britain has almost as miscellaneous a character as the common saddle-horse. The prime coach-horse is either an ordinary light-formed Cleveland Bay, or the offspring of a pure-bred Cleveland mare and a three-fourths bred or thorough-bred racer stallion. "Cleveland Bays," says Professor Low, "are crossed by hunters or thorough-bred horses; and thus another variety of coach-horse is produced, of lighter form and higher breeding; and many of the superior Cleveland curricle and four-in-hand horses are now nearly thorough-bred." But coach-horses of approved power and action may be produced by any one of many kinds of crossing, which has a due regard to strength and form, and to the infusion, direct or indirect, of some of the speed and spirit of the racer. "The coach-horse," remarks Youatt, "is nothing more than a tall, strong, over-sized hunter." In fact, it may be anything which can run with sufficient speed before a carriage; and—to the disgrace of

Britain, and mainly as an incidental effect of the perverting and demoralizing spirit of the race-course—it has very extensively become a light creature quite incompetent for the draught assigned to it, barely able to carry its own body at the rate of speed at which it is driven, and performing all its work in torture, and with such an enormous over-expenditure of strength as soon entails ruin and constant pain upon its constitution. The post-horse and the stage-coach-horse, in particular, have long been in a condition to horrify foreigners, and to award to Britons the infamous reputation of being the most cruel nation in Europe. Railways were invented just in time to prevent Britain from lacerating and murdering these animals faster than they could be produced.

The heavy black horse, or old English black horse, is the native though improved breed of the midland counties of England from Staffordshire to Lincolnshire. It is always large in size, with broad breast, large and muscular fore-arms and thighs, and somewhat short legs; but it comprises three great subvarieties, which may be designated respectively the heavy dray-horse, the heavy waggon-horse, and the heavy country cavalry-horse. Its characteristic defects are excessive bulkiness, comparative slowness of motion, and comparative sluggishness of action. Yet, in its characteristic state as a distinct breed, it not only possesses great intrinsic excellencies, but constitutes a rich and powerful fund for the production of many valuable subvarieties of draught horses by crossing. Mr. Bakewell was well aware of its value, and made it the basis of his improvement of the draught-horse; and many more recent improvers have highly appreciated it, and made it either the sole or the principal basis of their crossings with the Flemish horse. One of the most noted varieties of it is the enormous dray-horse of London, which so generally excites the astonishment of foreigners; and this is not more remarkable for size and power, than for tractability and good temper. "The docility of this breed," observes Mr. Bell, "is as complete, although not perhaps so showy, as that of the lighter and more active kinds; and few persons can have long walked the streets of the metropolis without witnessing the complete control which the draymen exercise over their gigantic horses. I have often watched the facility with which one of them will back a waggon into a narrow street or archway, but a few inches wider than the vehicle itself, and guided only by the voice of the carman, aided perhaps by a few slight movements of his hand." The largest are bred in Lincolnshire; and are seldom less, at 2½ years old, than 17 hands high. A well-formed one has thick upright shoulders, a low fore-hand, a deep round barrel, high and broad loins, large quarters, thick forearms and thighs, short legs, and hoofs round in front and broad at the heels.

The Suffolk horse, or Suffolk punch, is a descendant of the Norman stallion and the old Suffolk cart-mare. It is neither tall nor very handsome; but is compact, and has exceedingly good action and excellent dispositions. It is preferred to every other horse for the plough, in Suffolk, Norfolk, and Essex; and it is often crossed with horses of other breeds, and particularly with the Clevelands and with such as have some of the properties of the racer, in order to adapt it to other purposes, or to improve its lightness and action. The original Suffolk punch took its name from the county where it most abounded, and from its own round punchy shape; and, like the original Cleveland, it has now become very scarce. It stands from 15 to 16 hands high, and is large-headed, low-shouldered, thick-topped, deep and round chested, long-backed, high-crouped, large and strong quartered, full-flanked, round-legged, and short-pasterned; and it throws its whole weight into the collar, and has sufficient activity to do this with great effect, as well as sufficient strength and endurance to perform a long day's work. The somewhat modernized variety of it, as it prevailed about half a century ago, is described as follows by Mr. Culley: "Their merit probably consists more in constitutional hardiness than true shape; being in general a very plain made horse. Their colour is mostly yellowish or sorrel, with a white ratch or blaze on their faces; the head large, ears wide, muzzle coarse, fore-end low, back long but very straight, sides flat, shoulders too far forward, hind quarters middling, but rather high about the hips, legs round and short in the pastern, deep-bellied, and full in the flank. Here, perhaps, lies much of the merit of these horses; for we know from observation and experience, that all deep-bellied horses carry their food long, and consequently are enabled to stand longer and harder days' works. However, certain it is that these horses do perform surprising days' works. It is well known that the Suffolk and Norfolk farmers plough more land in a day than any other people in the island; and these are the kind of horses everywhere used in those districts." The Suffolk punch which now prevails, however, is inferior to that of half a century ago, and no longer gives the Suffolk or the Norfolk farmer the boast of ploughing more in a day than farmers of other districts; yet it is still a valuable animal both for the heavy draught and as a basis for crossing, and possesses some peculiar points of form and disposition which are of great utility; and, in particular, it has a lowness of position in the shoulder which enables it to throw an enormous power into the collar,—and it will steadily pull at any amount of undue weight to the utmost possible exertion of its strength.

The Clydesdale horse corresponds in Scotland to all the best heavy draught horses of England, whether true Clevelands, Suffolk punches, old heavy blacks, or crosses of any of these with one another or with the Flemish horse. It originated in the district of Clydesdale; but has, for a considerable time, been quite common throughout the best agricultural parts of both the western and the eastern Lowlands. It sprang first from crossing the best native mares with Flemish stallions, and afterwards from a progressive course of breeding from Flemish mares, and of other kinds of crossing, and of assiduous attention to general good treatment. It came first into distinct notice considerably upwards of a century ago; and it very long continued to improve, or at least to resist deterioration; but, in consequence of very infrequent recourse to the Flemish stallion, of an abundant breeding from small Highland mares, and of extensive inattention to the proper adaptation of true Clydesdale stallions to true Clydesdale mares, it has very visibly degenerated,—or, at any rate, any average market show of horses in even the towns of its native district, contains but a small proportion of quite genuine Clydesdales, and a large proportion, of more or less inferior animals. A true Clydesdale horse is larger than the Suffolk punch, and has a better-shaped head, a longer neck, a lighter barrel, and longer legs; and is strong, hardy, and steady, and in general well-dispositioned. "The Clydesdale horse, as it is now bred," says Professor Low, "is usually 16 hands high. The prevailing colour is black; but the brown or bay is common, and is continually gaining upon the other, and the grey is not unfrequently produced. They are longer in the body than the English black horse, and less weighty, compact and muscular, but they step out more freely, and have a more useful action for ordinary labour. They draw steadily, and are usually free from vice. The long stride characteristic of the breed, is partly the result of conformation, and partly of habit and training; but, however produced, it adds greatly to the usefulness of the horse, both on the road and in the fields. No such loads are known to be drawn, at the same pace, by any horses in the kingdom, as in the single horse carts of carriers and others in the West of Scotland. The Clydesdale horses, although inferior in weight and physical strength to the black horse, and in figure and showy action to the better class of the draught horses of Northumberland and Durham, yet possess properties which render them exceedingly valuable for all ordinary uses. On the road, they perform tasks that can scarcely be surpassed; and in the fields they are found steady, docile, and safe."

The Galloway horse was a beautiful, stout, fleet, sure-footed, mountain-scaling creature, commonly not quite 14 hands in height, but sometimes a little taller, of a bright bay or brown colour, with small head, small neck, and black, deep, clean legs; and it was a native of the district of Galloway, in the extreme south of Scotland, and is traditionally said to have descended from some Spanish horses which were thrown ashore in the wreck of one of the ships of the celebrated Armada. But it was very generally subjected to a process of cross-breeding with the view of producing an animal of greater size, and better adapted to the purposes of agriculture; and, except in a few instances in such remote situations as the island of Mull, it has almost utterly disappeared. Yet so generally was it appreciated as a peculiar and valuable breed, that the name of galloway continues to be given to every horse which is supposed to resemble it in size and hardiness. Dr. Anderson describes it as small and elegant, and as similar to the horses of Sweden and Iceland; and says respecting an individual of it which was bought for him when he was a boy, "In point of elegance and shape, it was a perfect picture; and in disposition was gentle and compliant. It moved almost with a wish, and never tired. I rode this little creature for 25 years; and twice in that time, I rode 150 miles at a stretch, without stopping, except to bait, and that not for above an hour at a time; and it came in at the last stage with as much ease and alacrity as it travelled the first." A large proportion of the horses now called galloways are large individuals of the Highland, the Welsh, and the New Forest ponies.

The Highland pony is the small native horse of the Scottish Highlands. It lives almost wholly in the open air, both in summer and winter; and is very hardy in constitution, and quite a mountaineer in habits. But it is very far from being equal in value to the old galloway; and it moves with comparative slowness, and has no easy pace for its rider except an amble. Its head is comparatively large; its back is comparatively long; its front is low; its legs are short; and its pasterns are upright. "When Highland ponies come to any boggy piece of ground," says the Rev. Mr. Hall, "they first put their nose to it, and then pat on it in a peculiar way with one of their fore-feet; and from the sound and feel of the ground, they know whether it will bear them. They do the same with ice; and determine in a minute whether they will proceed."

The sheltie, or Shetland pony, is an inhabitant of the Shetland Islands. It is so very small in size as to seem almost like a toy; but is very beautiful in shape, and very docile and sweet in disposition, and has a strength and an endurance enormously greater than might be expected from its size and appearance. Its usual height is from 7½ to 9½ hands; its head is small; its neck is short; its shoulders are low and thick; its back is short; its quarters are large and strong; its legs are flat and clean; and its feet are round and handsome. It eats almost any kind of food, and thrives and fattens in very disadvantageous circumstances; and, when it has a height of about 9 hands, and is ordinarily well fed, it will carry a rider in a journey quite or very nearly as well as many a tall road hackney. Small shelties are extensively used in Lowland Scotland and in England as riding horses for young children.

The Welsh pony is a singularly beautiful little animal; and is said to be indebted for much of its form and qualities to a single celebrated sire. It lives and thrives on almost any kind of food; and has very extraordinary powers of endurance. Its head is small; its barrel is deep and round; its withers are high; its legs are flat; and its feet are round and well-formed. It lives in a half-wild state in some of the most remote and rugged alpine districts of Wales; and the hunting of it was a favourite sport of the break-neck fox-hunters of a century or two ago, and has not yet been altogether forgotten by some of the roystering Welsh farmers.

The New Forest pony has had a long descent, and was formerly more celebrated than at present, and is said, like the Welsh pony, to have derived much of its excellence from a single distinguished sire. It equals some of the best small breeds of the north of Europe in spirit, hardiness, speed, sure-footedness, and utility; but it is inferior to most of them in beauty of form,—being an almost mis-shapen looking creature, with large head, short neck, and ragged hip. It runs at large in the New Forest; and is as difficult to be caught as the wild horse of South America.

The Exmoor, Dartmoor, and Wildmoor ponies have a general resemblance to the New Forest pony. The Exmoor pony is very ill-shaped, but has enormous power, and great hardiness and utility. The Dartmoor pony is larger and still more mis-shapen than the Exmoor one; and it roams on the Dartmoor in very nearly a wild state, and possesses wonderful nimbleness and agility, and cannot be caught without extreme dexterity and cleverness. The pack-horse in use in the western and southern parts of Devonshire is either a somewhat enlarged variety of the Dartmoor pony, or a considerably enlarged variety of the Exmoor one. The Wildmoor pony was never of high service in the fens, and always unfit for travelling on very hard ground; and it is now in the fair way to become speedily extinct. Its head is large; its fore-hand is low; its height is generally less than 13 hands; its back is straight; its legs are flat; and its feet are extraordinarily large.

The common Irish draught-horse is used, not only for all the horse-work of the farm, but for steeple-chases, and for attendance at fairs, markets, and funerals; it is far too light for its proper labour as a draught animal; and, in general, it is miserably ill fed, and is stinted in growth and enfeebled in constitution by premature working, by miscellaneous working, by excessive working, and by very bad treatment. It is lower in stature than any of the ordinary draught-horses of Britain; and usually has a miserable and half-starved appearance; and is commonly entitled, in the language of the country, a garron. But many of the draught horses of Ulster, particularly of the best linen-manufacture districts, are strong, well-formed, good-conditioned animals. A native breed, also, hardy and sure-footed, but without either beauty or fleetness, occurs in Ulster; and another native breed, of very valuable character, and closely akin, in both origin and character, to the true old galloways, occurs in the Connaught district of Cunnemara,—the most characteristic and scenically grand part of what have been called the Western Highlands of Ireland. The Cunnemara horse, or Cunnemara pony, is traditionally traced to Spanish horses which escaped from the wreck of some ship or ships of the famous Armada; and it bears very obvious marks of Spanish origin, and has the same prevailing chestnut colour as the Andalusian breed, and appears to have been preserved, among the sublime fastnesses of Joyce Country and Cunnemara-Proper, in a state of great purity. It is usually from 12 to 14 hands high; and is always hardy, active, nimble, fleet, sure-footed, and enduring; and it retains the peculiar amble of the Spanish jennet, and is probably the fittest saddle-horse in the three kingdoms for either a delicate young lady or a bad male rider.

The Choosing of a Horse.—Many persons, when purchasing a horse, simply look at his general appearance, or at best look only at his bulk and teeth and paces; and thence decide whether he be worth the money asked for him, and will suit their purpose. A horse bought in this careless manner is almost certain to be a bad bargain; he may be quite unsuitable for the work intended for him; he may want strength, or speed, or endurance; or he may be lazy, vicious, unsound, unsafe, or exceedingly ill-trained. A purchaser, in order to make a common-sense bargain, must know, not only the aggregate appearance of the particular kind of horse which he wants, but the good points and the defects of horses in general, the structural developments on which the good points depend, the features and symptoms by which the defects are indicated, the precise conformation which secures any one special group or preponderance of properties, and the best methods of ascertaining the animal's temper and education; and he must enquire into all these, and bring his judgment to bear upon them collectively, before he makes his purchase.

Strength, in combination with requisite speed, and with the greatest possible action and docility, is the prime property in every kind of horse; and it always depends on the form of the chest, the mutual balance of limbs and body, and the general symmetrical development of bone and muscle. The form of the chest is a main point in even the race-horse; and distinctly indicates his power of breathing, his capability of prolonged running, and his general strength and durability. The ribs, the muscles, and the diaphragm, which encompass the passive lungs, move and heave in respiration, alternately bulging out and falling in by the successive action of inhalation and exhalation; and they require to have ample capacity and sufficiently free mobility, in order to afford full space for the accelerated performance of the functions of the lungs. When a race-horse is running, or when any other horse is exercising a high degree of strength, his blood flows through the lungs with an increased velocity proportioned to the degree of exertion; and unless his chest be large, and be easily acted on by the muscles, either the blood must make its transit but partially oxygenized, and pass to the other parts of the system in a state unfit for the due performance of its office, and in consequence allow the body to become fatigued for want of due nourishment, or the flow of it through the lungs is partially obstructed by the inability of the muscles to make a sufficiently great expansion, and the animal suffers a sensation of choking and congestion, and is almost on the point of being suffocated. A capacious chest, with freely distensible muscles, therefore, is essential to the continuance of any severe and protracted exertion. And when great speed is combined with due strength, the sides of the anterior of the chest are somewhat flattened, in order that the anterior extremities may be allowed to approximate; for without this arrangement, the centre of gravity would constantly shift from side to side during the locomotion, and the horse with a wide chest, instead of moving forward in a smooth gallop or smooth trot, would waddle like a duck. Hence, the front view of a swift strong horse presents a natural ellipsis.

The trunk of most horses is quite sufficient in length; but that of very many is deficient in breadth. A long body supported on broad and muscular loins is advantageous; and the whole trunk of every horse ought to describe a sweeping natural outline of two gentle and unequal curves,—the greater curve extending from the withers to the quarters, and the smaller thence to the stump of the tail; and though the latter curve might seem of little consequence, it is really very important,—for a horse with a tail not well set, so as to form a good curve, is rarely if ever a good goer. But the trunk, besides being symmetrical and properly curved, must be supported by well-adjusted and duly-proportioned limbs, and carried forward by a nicely-balanced play of the various organisms of the legs and the feet; it must also rest fairly and evenly on the limbs, otherwise the motions are awkward or unsafe, and some part or other is unnaturally strained; and, in order to its being carried safely, speedily, and smoothly forward by the propelling action of the hinder extremities, it must be connected with a well-sloped, clean, and muscular shoulder, strong and lengthy arms, powerful and firm-tendoned shanks, well-set fetlocks, and sound, well-formed, and fairly-adjusted feet.

The fore-extremities are principally concerned in the freedom, the smoothness, and the safety of action; and as they are subject to several very serious malformations and faults, they ought to be closely examined. The fore-feet, in order to insure accurate motion, must, in a front view, stand parallel with the sides of the animal's body; and the toes must point forward, and not be much turned either inward or outward. When the toes are turned inward, the horse is awkward in action, and continually liable to stumble, and is also subject to splints and injuries of the fetlock; and when they are turned outward, the foot comes in contact with the opposite leg, and bruises it,—the pasterns, at the same time, are generally too long, so as to cause a great strain upon the tendons, and to render them liable to disease,—the action is almost invariably low, and very liable to dangerous tripping and stumbling,—and the feet accommodate themselves to the form and position of the limbs, and become very liable to several diseases. The feet should be sound; and the hoofs free from grogginess. Flat feet, with low heels, are particularly bad.

The hind-extremities are principally concerned in both the power and the speed of action; they require, in all cases, to comprise long quarters, strong loins, and well-formed legs; and, in different animals, they exhibit certain varieties of conformation in peculiar fitness for the different kinds of pace. "For galloping," says Professor Dick, "the lengthy horizontal or finely turned quarter, and lengthy thigh, are best adapted for speed; while for trotting, there is a greater degree of sloping in the quarter, which is less pleasing to the eye than the galloping quarter, and a rotund muscularity well observed in all fast trotters. In all, however, this muscularity indicates great strength and action, more especially if it is observed, on viewing the animal from behind, that there is a fine arch, from haunch to haunch, over his quarters, and that there is such a swelling out of the muscles of his thighs, that, when measured across, there would be a greater breadth than in his haunches. The limbs should then gradually approximate each other, tapering with the diminution of the swell of the muscles as they send off their tendons, until they reach the hocks. To this point the eye must be scrupulously directed, because there is no point of more importance in regard to action, and none so liable to disease; these diseases, too, depending upon the formation of the part. Unless the hock is well-formed, there cannot be durability; and if there is sometimes speed with a badly formed hock, it is never for a long run. The most common defect which at present exists is a liability to curbs, such being denominated curby hocks; these are seen, on taking a side view, by the smallness of the leg below the hock, by the great projection of the point of the hock, and by a bent-like appearance at the lower part of it, with a greater or less tuberosity at the back part; these hocks are also more liable to spavins and other diseases of the hock-joints. There is also an opposite form of hock which is too straight; this is connected with a great length of pastern, and is liable to thorough pins in the hock, windgalls and sprains of the suspensary ligament at the fetlock joint. A well-formed hock, viewed from behind, should stand with the toe of the hoof, and the fetlock, in a line running parallel with the body; or, if altered from that direction, the toe should incline a little outwards. The tendon forming the ham-string should stand clear and free from the back of the leg above the hock; and the back part of the leg from the hock, viewed laterally, should descend from the points of it to the fetlock in a straight line, or if otherwise, rather scooped out below the point of the hock than in the opposite form. The tendons should be clean and well marked; and the shank equal in breadth at the hock and fetlock, and the broader the better. The limbs can scarcely be too short, if combined with the qualities we have mentioned; but the shanks from the hock and the knees to the ground should be selected as short as possible; and that these parts may be divided in due proportion, the fetlock should stand with the rest of the limb and the foot at an angle of 45 degrees, in which case it will be of a proper length and proportion."

The first thing, in choosing a horse, is to see, by a general glance, whether the animal seem to be of the breed and size and strength most suited to the purposes for which he is wanted. The next thing is to ascertain his age: and this is easily done by the aid of the criteria mentioned in our article AGE OF ANIMALS. The third thing is to observe the action, that it be high, extensive, and free. The action must be high, that it may be safe,—the horse lifting his feet well up, so as to escape all the ordinary inequalities of the road; it must be extensive, that the horse may make good speed,—the feet thrown well forward, and the strides long; and it must be free, that the horse may proceed uniformly, and with ease, the foot projected straight forward, and not taking sometimes a short step and sometimes a long one, but advancing steadily, and seeming to be under perfect control while in the air. The fourth thing is to observe the peculiarities of conformation which indicate strength, speed, and endurance, and to see that these are developed in such proportions as to serve the precise purposes for which the horse is wanted. Certain peculiarities in the shape, as we have seen, confer strength, and certain others confer swiftness; and the former or the latter ought more or less to preponderate, or the two ought quite or nearly to balance each other, according o the kind and amount and circumstances of he work which the animal will have to perform. When much of the one set of properties is wanted, a corresponding amount of the other set must be dispensed with; the enormous strength of the dray-horse can never be combined with the speed of the racer; the two sets of properties exist together in almost endless proportions, but always modify or control each other, and never truly combine; and the man chooses best who, after seeing that a peculiar fitness in other respects exists for the particular kind of work in which the animal is to be employed, chooses a shape which unites the greatest degree of speed with a perfectly sufficient degree of strength. When mere speed is the grand object, the horse's shape must resemble that of a greyhound; and when mere strength is the grand object, it ought to resemble that of a bull-dog. But whether the properties of speed or the properties of strength preponderate, the special configuration of chest requisite for full and long wind, and the special structure of all the parts of the limbs requisite for both daily and aggregate endurance, ought to be very distinctly present. Many a strong, active, good-chested horse has such defects in the limbs, that, though he may do hard work for a time, he cannot continue at it, but soon breaks down, and begins to decline in both strength and spirit.

The last thing, and a very important one, to be attended to in the choosing of a horse, is his temper and training. Many a horse, otherwise unexceptionable or eminently excellent, is so untractable or vicious in disposition as to be worse than useless. A fine calm eye and a pleasant countenance serve in some degree to indicate the temper; but the actual habits are better indicators of both this and the education, and may somewhat easily be put to the test. When a personal trial of a saddle-horse is not obtainable, something of both his temper and his education, but especially of the latter, may be learned by observing his conduct while he is led or ridden by another person. "See if he obey the bridle or collar rein, if he stop at once when he is checked, if he advance whenever he is commanded, if he turn to one side or the other without much bend of the neck, or looking as if he were turned by main force. A horse well mouthed, and of a good disposition, may have a will of his own; but he never shows it in opposition to that of his master; to every, and to the lightest touch of the rein, he yields implicit and prompt obedience. This is a very desirable quality; and you may meet with horses having it in great perfection. Observe also if he heed the voice of his attendant. If you see that he heeds neither rein nor voice, or that he answers tardily, you may justly doubt whether he is thoroughly educated. But there is no certainty without a trial; and if you desire a good horse, it is much better to give a few pounds more for one that you are sure will please you, than to purchase at a lower price one that you know nothing about. When a trial is possible, mount the horse and start at a walk. See if there be any lameness, for it is most likely to be discovered at starting; after the horse is out a bit, he disregards a slight lameness and does not show it. Observe next how he walks, if he step well out, taking a good long stride; if he walk smartly, four miles an hour is good walking, and five miles is very fast; see if he set down the foot all at once, the heel rather sooner than the toe; see that he do not trip often while walking. Observe also how he carries his head, and bears upon the bridle; if he carry it low, or bear heavy on the rein, as if he meant you to carry it for him, be sure you will not like him,—he will not be pleasant to ride,—he is not well broken. Take him next through a crowded street, still at a walk, and notice how he passes carriages and horses. He should himself incline to pass them on the proper side; but this is a thing which horses learn very slowly, and it may be forgiven him if he has not learned it. He should not start, stop, or shy, at objects of any kind; if he do, he is either uneducated, or too timid ever to be fully educated. Strange noises may be allowed to produce some animation in the horse's manner; but if they make him restive, disobedient or wilful, do not have him,—his timidity or awkwardness will get you into a scrape. From a walk, you urge the horse to a trot. There is a great difference in the trot of different horses; in one it is easy; in another, rough; in another, quick; in another, slow; and in very many horses, it is neither one thing nor another, but a curious provoking sort of compound, of shuffling, trotting, walking, creeping, and cantering, all in one. This last is no doubt meant for a trot, but is a sorry imitation. You would suppose the beast had never tried it before; his legs flounder and scramble, as if every one were fighting another; and the motion altogether is so odd that you can hardly tell which way you are going, whether forward or backward, to the right or to the left. If you want a trotting horse, you will, of course, have nothing to do with a beast of this sort. He may nevertheless be a good canterer. The canter, the walk, and the gallop, are natural paces; the trot is altogether produced by training; and you need not therefore wonder that the trot is often worse performed than any of the others. The horse is generally taught to canter with the right foot forward; but the individual is best taught who changes from the one foot to the other, sometimes with the right, and sometimes with the left in advance. When well trained, the horse is what they call 'collected' in his centre—that is, he leaves the ground and meets it without any jerk; you are not jolted out of the saddle, and you find no difficulty in keeping the stirrup still, not oscillating backward and forward like a pendulum. After the canter you may try the gallop, for two or three hundred yards. It should be performed in long steady bounds, without jolting, and without irregularity. An inexperienced galloper takes a short stride, and makes a great fuss about it; and while all his strides are confined, some are shorter and some are longer. After the trial-gallop pull the horse up; let him stand for a moment, and slacken the reins; then cast your eyes upon the fore legs; if they be weak or badly formed, they will tremble. Some nervous horses will shake a little merely by the agitation of galloping; but in these horses the trembling is rarely perceived in the second short gallop; and you may easily see by other signs, such as champing the bit, pawing the ground, and animation of the ears, that fieriness of temper has more to do with it than any fault in the legs. For any work besides the saddle, the trial must be somewhat different. If the horse be meant for hunting, you must try how he can leap; if for harness, you must harness him to a gig or a coach; if for the cart or the dray, you must see that he is willing to draw a full load. Laziness is as much a characteristic of some horses as of some men; and it is often an incurable malady; and not a trace of it should be perceptible in the horse you purchase. If he require much of the whip and the spur, with a full load, he possibly would be a bad bargain were he given to you in a present; and even though he should work well for a short distance or in company with another horse, he may, on being tried over several miles or without any company, prove an incorrigible sluggard."

The Breeding of Horses.—Both private interest and public duty require all extensive farmers, for some considerable time to come, to pay special attention to the improving of the breeds of horses. Some of the principal British breeds, as was shown in a former section, have exceedingly deteriorated; two or three good ones are almost or altogether extinct; and all which possess any general value to the country have either lost much of their intrinsic excellence or become exceedingly scarce. One of our most distinguished veterinarians said, so long ago as 1831, "There must be something radically wrong in our breeding system. If we proceed to the great marts, we find a remarkable scarcity of anything in the shape of a good nag. It matters not for what purpose he is intended, whether for racer, hunter, carriage, hack, or heavy draught, the difficulty of making a good selection for either of these purposes is the same. There may be thousands in the market, but how few, in the eye of a judge, will be even passable for any purpose. Good horses have been becoming gradually scarcer in our fairs for the last 20 years; and we find, that many of what were considered the most useful sort have now entirely disappeared,—the breed is quite extinct. Where, for example, do we now find the fine, short-legged, handsome cob, whose action and strength enabled him to go any pace, and to carry any weight that could ride? How few of the splendid carriage-horses which were met with 15 or 20 years ago are now to be seen! Nay, how few of anything really good is there to be met with!"

A demand for British horses, throughout very many parts of Continental Europe, burst out immediately after the peace of 1815, and made such excessive inroads upon all our great markets as rapidly to take away from our country a main proportion of all our best stallions. Had the demand been made for our inferior kinds of stock, or even for horses of all sorts just as they are sent to market, it might have greatly increased the stock-producing trade, and added very materially to the wealth of our agricultural community. But it was a demand for only the best individuals; and it rapidly drained our country, not of its produce in horses but of the original stock,—not of the proceeds of its industry, but of the very means by which these were produced. Good stallions soon became scarce and exceedingly high-priced; and good mares —which had formerly been shut out from the London market, and regarded as unfit for the purposes of the cavalry—were now brought into requisition, and multitudinously bought up for the supply of the army. Farmers, after having been generally deprived of access to good stallions, were thus extensively induced to part also with their good mares; and many of them began to produce horse-stock of all sorts, but especially of the half-bred, the three-fourths bred, and the heavy draught kinds, from mares which were almost useless for any other purpose. The consequent deterioration of horses, particularly in Scotland and in the northern counties of England, was, in many instances, so great as nearly to exceed belief. Many a small, misshapen, feeble mare was used for breeding; and even when a mare of this sort was served with a tolerably good stallion, she incurred every hazard of producing a worse than worthless foal. "What is the consequence? The foal is reared; it is sold by the breeder at perhaps half the sum it has cost in rearing; it never pays for half the food it has destroyed; and the breeder is continually crying out that breeding does not pay. How much less will it repay him for the risk he runs? For it is not like a bullock, which will sell even if it has a lame leg, a badly-formed leg or joint. No; if any accident befall it—and to how many accidents and diseases are foals liable?—it is rendered good for nothing. But the loss does not stop with the breeder; the purchaser has his sorrows to commence. He gets his horse put in condition; and the horse is mounted a few times; but it is found that he is unable to carry his rider with pleasure or safety; his spindle shanks give way, he knocks the one against the other, he cuts, he falls, he is sprained, has curbs or spavins, is washy and delicate, and, in short, is more plague than profit, and after some time he is sold at a loss, and, passing from one hand to another, proves to each a similar annoyance." The consequent diminution of the national agricultural wealth is enormous. If the total number of horses in Britain be assumed at 1½ million, if the number of such degenerate individuals as we have described be assumed at one-tenth of the total, and if each individual be supposed to cost £25 in rearing till he is four years of age, and to be then sold for three-fifths of his cost; then, on the liberal and almost romantic assumption that all are worth their meat from four years upwards, the loss to the nation upon every generation of horses amounts to the sum of £1,500,000!

Farmers, then, from motives both of self-interest and of patriotism, must pay close and enlightened attention to the principles of improving all our breeds of horses. Such of these principles as are of a general kind, and depend upon physiology, comparative anatomy, and the modifying influences of climate and treatment, are discussed in our article BREEDING; such as concern the modifying effects of hybridizing between closely allied breeds, are discussed in our article CROSSING; such as concern the special points and distinguishing excellencies of each particular breed, may be readily inferred from the sections, "Foreign Breeds of Horses," and "British Breeds of Horses," in the present article; and only such as concern the animal mechanism, the sound constitution, the good health, the good temper, the uniform pairing, the proper age, and the suitable condition of the sire and the dam, together with the proper time of the year for breeding, require to be noticed in the sequel of this section.

The animal mechanism of both the sire and the brood-mare ought to possess the precise developments on which depend the requisite strength, the requisite speed, the requisite endurance, or the symmetrical combination of strength, speed, and endurance, in the best variety or normal state of each particular breed. A judicious farmer, in selecting horses for breeding, will be guided by the same rules as in choosing market horses for immediate use,—only he will apply the rules with greater rigidness, and will balance or proportion them between the sire and the dam with a precise view to any desired modification in the mechanical conformation of the progeny; and these rules have been already laid down in the section, "The Choosing of a Horse." But the animal mechanism, particularly that of the mare, must be sound and normal, not only with reference to the ultimate working power of the animal, but also with reference to the vigorous performance of the functions of reproduction. Comparatively few stallions or mares are free from defects of form; and many mares, of average value as working-beasts, are so seriously mis-shapen or feeble as to be incapable of maturing a vigorous fœtus. Thus a brood-mare who has weak stomach and intestines, who feeds without relish, and voids a crude and sloppy excrement, cannot possibly digest sufficient food to supply her own wants and those of the fœtus; and a mare who has weak respiratory organs, and whose blood passes through the lungs but partially oxygenized, can never possess in her own proper organism, or impart to the organism of her fœtus, the functional vigour of muscle, sinew, or nerve, which results from perfectly-formed secretions. Every farmer, therefore, ought to pay the utmost attention to the form, powers, and constitutional energy of his brood-mares, and to reject every mare from breeding who does not amply and very obviously possess these essential properties of sound animal mechanism.

Soundness of constitution is as essential as good form, and is very nearly akin to it, but has reference to functional habits, while the other has reference to organic configuration.. A badly formed horse is very likely to have a bad constitution; but even a well-formed horse may have a bad constitution,—if not in breathing, at least in digestion and in some important secretions. A good constitution is essential both to vigorous reproduction, and to the functional soundness of the progeny; and is requisite in both the sire and the dam. The foal of either a badly-constitutioned mare with a vigorous stallion, or of a vigorous mare with a badly-constitutioned stallion, is almost certain to be weak and unthrifty, either undersized or leggy, and utterly incapable of repaying the cost of producing and rearing it. A farmer ought always to prefer, when he can, a stallion of proved soundness or well-established reputation; and when he must employ one of unknown character, he ought at least to satisfy himself well respecting the animal's compactness of form, and fulness of chest, and power about the joints; and, as to the mares, he ought to have had them long in his possession, and to have been closely observing them, and to have acquired a thorough knowledge of their constitution,—and he must, by no means, make use of any one for breeding who has any perceptible defect or weakness in any considerable function.

Good health, but especially perfect freedom from every kind of chronic and hereditary disease, is indispensable in both sire and dam. By far the greater number of both the active diseases and the morbific defects of horses are transmissible from either the sire or the dam to the offspring. Even certain diseases of the eye, and contraction of the feet, and founder, and spavins, and ring-bones, and the very habit of rearing, and much more the severe chronic diseases or morbific defects of the lungs, the stomach, and other internal organs are hereditary. Yet "some distinction," suggests Mr. Burke, "is to be made between congenital and acquired disease. Thus, for instance, a mare with curbs, although put at various times to different horses, has been known constantly to bring forth foals afflicted with the complaint of the dam; and such an animal should consequently be rejected from the stud by the careful breeder. But should a mare throw curbs from any sudden and violent exertion of the hind legs, as in taking some extraordinary leap, or in struggling through very deep ground with a heavy weight on her back, it is questionable whether her progeny will inherit a defect thus produced by accident; as, in like manner, a racer that has broken down from great exertions on the turf, does not procreate offspring similarly diseased. Still, after some lapse of time, it is not impossible, nor indeed improbable, that the progeny of such a horse may be foaled with congenital weakness of the back-sinews, which may terminate in a rupture, similar to that of the sire. It is consequently better, if possible, to breed from animals that are in every respect sound; and if one of the parents have any peculiar defect—as, for example, a very large head, or somewhat straight shoulders—it should be corrected, as far as may be, by a corresponding point of superior excellence in the other."

Good temper is of great importance in both the sire and the dam; for bad temper in either is almost certain to be inherited by the offspring. Docility, willingness to work, and sufficient resoluteness to keep up a constant and steady pull, but without any touch of stubbornness or of an absolute spirit, are valuable qualities in both parents, and will diffuse all their worth into the foal; but an intractable disposition, or an untameable fieriness, or a fitful unsteadiness, or a general viciousness in either parent, may be so fully entailed upon the offspring, or even exaggerated, as to render the finest combination of mere physical properties almost totally useless. A team of steady-pulling draught-horses is invaluable to a farmer who cultivates a very stiff and heavy soil; and when horses of considerably different lightness and steadiness and docility exist together on one farm, two of different weight and disposition ought never, if possible, to work in the same team. A horse of more spirit and courage than his fellows, may, on attempting to start with a heavy draught, fruitlessly strain himself to the serious injury of his muscles before they even begin to draw; and though kept back and occasionally patted by the driver while at work, he may perform a great part of his labour by such jerks and sudden tugs as shall occasion a very wasteful expenditure of his strength. A farmer, therefore, in selecting brood-mares and stallions, ought not only to avoid all downright bad temper, but to aim at producing such similarly dispositioned foals as will eventually give him two or four of the same weight of body, and the same structure of frame, and the same cast of temper for the working of every plough or waggon.

The pairing of a brood-mare with the same kind of stallion, at subsequent impregnations as at the first impregation, is a point of much consequence. Whatever be the breed or aggregate properties or peculiar characteristices of the stallion used in the first impregnation, they are very likely to exert a controlling influence on all future impregnations, even though the stallions employed in these should be of widely different breed or possess a widely different aggregate character. A mare of nearly pure Arabian blood, in the stud of the Earl of Morton, was crossed with a male quagga, and produced a female hybrid of a character intermediate between that of the quagga and the horse; and she was afterwards impregnated, at two successive periods, by a fine black Arabian stallion, and produced first a filly and then a colt, of distinctly equine formation, but marked with very distinct resemblances to a quagga. These animals, the direct offspring of the Arabian mare and the Arabian stallion, had the quagga's peculiar stripes or lists along the back and across the forehead; and the filly's mane was short, thick, stiff, and upright like a quagga's; while the colt's mane was much larger, but so stiff as to arch upward, and hang clear of the sides of the neck. Other trials of direct and pure equine impregnation were made with the same mare, in the hope that a repetition of them would eventually efface the impression made by the original quagga impregnation; but the oftener they were repeated, the more distinctly did they result in offspring with quagga markings, and the more strongly did they seem to prove that the influence exerted by the first impregnation was, in a certain degree, permanent and irreversible. So very curious was this phenomenon, and so seemingly unconnected with all the other known laws of animal reproduction, that a person might almost be tempted to refer it to something peculiar in the particular mare; but phenomena strictly similar to it have been observed, not only in other horses, but also in cats, dogs, and swine. If, therefore, any mare, otherwise thoroughly suitable for breeding, have happened to produce a first foal of widely or even considerably different character from what her owner now wants, she ought either to be rejected as a brood-mare, or to be consigned back to a reproduction closely similar to her first.

The proper age of both sire and dam is a consideration of much importance. A filly who breeds before she is three years old will probably produce a feeble, diminutive, and sickly foal; and even one who breeds at any time between three and five years of age, though she may produce a good enough foal, will probably suffer very considerable injury herself, and be rendered unfit for vigorous breeding in after-life. A mare, even when duly fed and well managed, continues to mature her constitution, to make increments to some parts of her frame, and to consolidate and strengthen her general organism till she is five years of age; and if she breed before that period, she first gives to the fœtus a very large proportion of the assimilated substances which ought to be secreted for the maturing of her own system,—she afterwards parts with another large proportion of the same substances in the secreting of milk for nourishing the foal,—and, in consequence, she never attains the bulk and stature which she would otherwise have possessed, and is permanently less valuable than she ought to be, and does not acquire sufficient energy for imparting a maximum strength and fulness to her future progeny. But a mare who does not breed till she is five years old, may probably continue to breed with complete vigour till she is twenty years old; and some of the finest, well-treated, high-blood mares, especially when the precaution was used of allowing them to breed only in every alternate year, have continued to produce a perfectly full, strong, and energetic progeny till they attained the advanced age of thirty or even of thirty-six.—A colt of only two years of age may, in a rare case, be the sire of a promising and useful foal; but no male can be safely or certainly employed in any instance of even ordinary importance, at an earlier stage than as a well-formed, vigorous, compact stallion of seven or eight years.

The suitable condition of the sire and the dam is a consideration additional to animal mechanism, sound constitution, good health, good temper, uniform pairing, and proper age, and respects the state of both in regard to exercise and food, and their adaptation to each other in regard to size. If either sire or dam, though in all other respects perfectly unexceptionable, should, at the time of copulation, have sunk into a relaxed state of the muscular system from the want of due exercise, the offspring will probably be deficient in constitutional energy; and, for a similar reason, if either should have suffered a diminution of strength from insufficiency of food or from any other cause of debilitation, the offspring will probably be correspondingly deficient in both functional power and muscular development. The dam, too, must not only be in full energy from exercise and food at the time of her impregnation, but must continue to be so throughout all the time of her gestation; for unless her foal be fully and energetically supplied with all the principles of increment and nourishment from the first moment of its embryo state, and throughout all the stages of its fœtal existence, it will never, with even the best and most sedulous appliances of subsequent suckling and feeding, be able to develope ample muscle or acquire the full and due energies of its nature. But though both sire and dam ought to have been well fed, they ought not, by any means, to be in a fat or pampered condition. A stallion overloaded with fat, though much desired and eagerly preferred by many farmers, is really in a morbific state, and almost as exceptionable as if he were lean, thin, and half-starved; for he has acquired his excessive fat mainly in consequence of a weakness in the organs of assimilation, and has, in connexion with it, been rendered sluggish and incapable of great or continued exertion; so that his offspring will probably be, to the full, as spiritless and feeble as that of a lank and half-famished but constitutionally vigorous stallion. The connecting of a small-sized mare with a comparatively large or huge stallion is also a serious evil; for it diminishes the development of the fœtus by the insufficiency of aliment afforded to it during gestation,—it entails danger upon the dam at the time of parturition,—and it occasions a stinting and partial starving of the foal by an inadequate supply of milk during the time of suckling.

The time for pairing recommended by most writers is May; but though this has great advantages, and may be properly enough named as a general rule for the whole of Great Britain, by far the best time in all genial situations, and particularly throughout most of the south and the centre of England, is about the end of March or the beginning of April. A mare's period of gestation is about eleven months; and when this terminates about the end of February or the beginning of March, the foal needs little or no artificial food, but is supported by milk during the proper length of time, and becomes able to nibble at the pastures just when the season ceases to be cold and the grass lands begin to be full of sweet and nutritious herbage. When a farmer wishes to obtain a good hunting-horse, a month later may be proper. "But," says Mr. Burke, "if his mare be thorough-bred, and he wish to take the chance of having a foal with some pretensions to running, then the earlier a mare is stinted the better; for all running horses date their birth from the 1st of January, be they foaled when they may; and consequently it is of great importance that they be dropped as early in the year as may be, in order that their growth may be forwarded by every means that can be devised consistent with their healthy state. It is a question, however, whether very early foals, that are kept for months on artificial food, will be more forward at two years old than those dropped towards the end of the spring, and properly attended to subsequently."—The subject of crossing heavy draught mares with Flemish stallions is noticed in the paragraph on the Flemish horse, in the section "Foreign Breeds of Horses."

The process of breeding and rearing horses may be very fairly or even amply remunerating, when conducted with consummate judgment and great care; but is decidedly uncompensating, as conducted by the majority of farmers. A very good cart-horse, of any kind whatever except the stupendous and showy dray-horse, can rarely be estimated at a higher market value, when he is four years' old, than £40; and though he be assumed to earn all his own keep during the fourth year of his age, he cannot, in even a favourable general estimate, be supposed to cost his owner a less amount of dead outlay than £26,— or £2 for the stallion, 14s. for the keep of the mare during a month at foaling, £19 10s. or 3s. per week for the keep of the colt at grass and in the straw-yard from the time of weaning till the close of his third year, £1 16s. for daily allowance of corn during the three months of his being broken-in, 8s. for the wages of the breaker-in, and £1 10s. for the extra feeding of the colt preparatory to selling him, and for sending him to the fair. The extreme profit, on the whole transaction, therefore, will be £14.—A very fine carriage colt which will bring about £60 in the London market, may be favourably estimated, in the same way, to cost a dead outlay of about £40,—or £3 3s. for the stallion, 14s. for the keep of the mare at foaling, £30 1s. for the keep of the colt till the close of his third year, and £2 2s. for breaking-in; so that he will yield an extreme profit of about £18 or £20.—A hunting-horse, of middle-rate powers, and worth £50 or £60 at the end of his fifth year, may be bred and reared in the same circumstances as ordinary colts; but a hunting-horse, of any pretensions to superior character can, in general, be bred and reared only under the direction of a man who knows the nicest and most important points of the many subvarieties of the horse, and has an acquaintance with the pedigree, performances, and general character of the prime mares and stallions of the day; and a hunter of any sort does little or no harness-work, and must be kept till he is at least five years old before he can be sold for his full value, and can seldom or never bring a high price till he has acquired a character by actual performances in the field; so that every hunting-horse occasions a comparatively large cost for breeding and rearing, and, at the same time, is a downright lottery to his owner, and may either yield a good profit or entail a heavy loss.—In all cases of breeding and rearing, be they what they may, losses are liable to occur from accidents to the mare, from risk at parturition, from mistakes respecting the true character of the stallion, from unexpected and untoward character in the colt, from neglect or mismanagement on the part of servants, from accidents to the colt, and from some other and equally obvious and inevitable causes; and these losses may occasionally be such as to render the process of breeding and rearing, even under the most skilful management, not only unremunerating but disastrous. But as to the multitudes who conduct the process in a mere routine manner, with little knowledge of its principles and no enlightened seizure of its advantages, additional and constant losses arise from sheer inadvertence and mismanagement, and, in the great majority of instances, render the idea of remuneration a mere fond delusion. "The real fact," remarks Mr. Burke, "is this. A farmer breeds a colt; and at five years old, the expense of rearing him may be £50. But this sum not having come out of his pocket at once, but having gradually and insensibly melted away in the shape of grass, oat-straw, and now and then a few quarters of corn, it has not at any one particular time made any great inroad upon his pocket, and consequently, if he want to pay his rent, or to make any purchase which is likely to be beneficial to him, he takes perhaps £40 for the colt that has cost him £50, and thinks himself both lucky to get that sum, and likewise a provident man, to have kept that by him that has been so valuable in a time of need." Yet—still to adopt the words of the same writer—"provided the farmer can rub on to sell the colt at an improper time, it may be looked on in the light of a live savings-bank, in which he weekly hoards up a certain sum which, under different circumstances, he would probably think nothing of spending."

The Management of Horses.—The proper succession of housing and depasturing, and of corn-feeding and grass-feeding, in the seasonal management of horses, is noticed in the article CALENDAR; the proper treatment of foals at birth, and during the period of rearing them, is noticed in the articles PARTURITION, FOAL, and FEEDING OF ANIMALS; the proper treatment of mares during the period of pregnancy, is noticed in the article ABORTION; the outline of right management in the training of colts, is drawn in the article BREAKING; the proper daily dressing of horses is noticed in the articles DANDRIFF and GROOMING; the due supply of air, light, and litter to housed horses will be noticed in the article STABLE; the principles of maintaining the functional energy of horses are stated in the articles AIR, FOOD, EXERCISE, FEEDING OF ANIMALS, and some others; the proper management of the feet of horses is noticed in the articles FOOT and SHOEING; the right performance of surgical operations upon horses is noticed under the titles of the several operations, such as DOCKING, BLEEDING, CASTRATION, FIRING, and BLISTERING; and the proper treatment of horses under disease is noticed under the titles of the several diseases, such as CATARRH, DIABETES, ENTERITIS, FARCY, FEVER, GLANDERS, INFLAMMATION, and STAGGERS. The only discussion of the management of horses required in this place, therefore, is merely a supplementary remark or two on training and exercise, and some notice of watering and feeding.

Every young colt of a spirited breed, especially if he be intended to serve as a hunter or as a prime hackney, ought to be early accustomed to the handling and control of a keeper. He ought, when two years old, to wear a headstall at grass, and to have attached to it a long rein; so that, at any time, he may be easily caught, without being startled, and may have scope enough for free movement when caught, without needing to contend with his keeper, or to jerk the rein from him and run away. If he have not a headstall, he cannot be caught without being alarmed and learning skittishness; and if he have a mere halter attached to his headstall, he will, on every occasion of showing temper or fright, oblige his keeper to hang and tug upon him, and subject himself to much jerking and irritation. He ought at first to be simply approached in a gentle and coaxing manner; and for a time to be much patted and caressed, to have a foot lifted, to be softly rubbed with a wisp of hay, and to be otherwise habituated to the presence and handling of his keeper. Never once should he, in even the slightest manner, be frightened and coerced; for every disturbing of his equanimity leaves a bad impression on his constitutional temper, and tends to make him either timid or rebellious. His earliest formal lesson, and one which requires to be very gently given and very often repeated, is to lead him about at the full length of his rein; and if he start or become playful during the lesson, his keeper ought to allow him the amplest possible scope for scampering and frolic, and to let him feel as little as possible of the restraint of the rein. After a few days he may, with great care and gentleness, be lounged in a circle, so as to be taught some of his paces; but with the least practicable formality or control, and in a manner of constant kindness and coaxing, and of frequent patting and caressing. All his lessons ought to be short and thoroughly pleasant to him; and when he has once acquired docility he may again be turned loose, and occasionally taken up for a few hours during the day for the purpose of repeating his lessons, so that he may enjoy a large degree of absolute liberty, and at the same time may not forget what he has learned. When the time for thorough breaking-in and total subjection arrives, he should be accustomed to the dumb-jockey, and steadily conducted through all the successive parts of breaking and training; and if he be intended for the chase or for rough and rapid country riding, he should be often led over small jumps and moderately wide blind ditches, in order that he may be gradually habituated to every species of fence, and rendered confident in his own powers. But the practice commonly observed by professional horse-breakers, of tightly reining up the head of the young colt to the dumb-jockey, and then turning him into a loose box during many hours of the day, is both unnecessary and cruel. This practice is usually said to "give the horse a good mouth;" but it really produces the opposite effect; while the kind and dexterous handling of a judicious horseman at once gives a really 'good mouth,' gives a good bearing along with it, avoids all cruelty, and entails no evil consequences.

The young cart-horse has, for the most part, a constitutionally quiet and tameable disposition; and does not require such precaution and nicety, in the initial lessons of handling and lounging, as the young horse with much blood. The best method of subduing and training him is detailed in the article BREAKING. But should the practice there recommended of harnessing him in a team be encountered by a disposition of restiveness and of kicking, he may be harnessed by himself to a billet or light log of wood, with long traces attached, in order that he may have free play for his heels without risk of hurting himself; and he should be led gently about in traction of the billet, and coaxed and wheedled rather than urged to proceed; and not till he learns to tug the light thing docilely and pleasantly and somewhat steadily after him, should he be harnessed with a team to an empty cart, and cautiously inured to perform a small degree of work.—"A medium plan must be adopted with the carriage-horse. He is not only required to have somewhat showy action, but likewise to be steady in draught. He must, therefore, be lounged like the hunter, and taught to raise his knee and deliver his leg with freedom,—motions which can never be acquired without the good exercise of the hands and legs of a perfect horseman. Previous to being made to draw, it is a good practice to drive such horses with long reins but unattached to any vehicle, the man who drives them running behind, and being furnished with a whip to keep them up to the proper pace. By this means, being guided in every direction, made to turn, back, &c., they will when harnessed be much less raw and unhandy than when simply broken-in to draw by ploughing and harrowing, to which work they may be put upon light soils when about three years old. If, also, the farmer exact but gentle work from his young stock, and can manage to employ them upon soft ground, the longer he can avoid having them shod the better; shoeing at an early age being the bane of young horses, and frequently crippling their feet so as to render them almost worthless."

The training of all kinds of horses ought to be sufficiently comprehensive to prepare them for every kind of work which they may be destined to perform, and for every kind of ordinary situation and exigency in which they may be expected to be placed. But even when executed by a professional breaker, and when formally declared, upon the sale of a horse, to be as perfect as it can be made by man, it by no means comprises any effort to prepare the animal either for extraordinary situations or for the blunders and cruelties of his future master. No breaker can anticipate what the folly or ferocity of a brutal driver may do to a horse; and even if he could anticipate it, he would himself become a fool, and only inflict needless pain and irritation, were he to attempt to fortify the animal against it. Breakers can train horses only for rational treatment; and if they would address themselves to the prevention of the accidents which arise from ignorance and brutality, they must apply the discipline for it, not to the horses, but to their drivers. "There can be no doubt," remarks the writer of Stable Talk, "that of the numerous accidents we often see and daily hear of, as occurring to gigs, phaetons, and other vehicles, three out of four arise from want of judgment in the driver. He is not aware of what is likely to produce accident, consequently takes no steps to prevent it. He has probably no conception that a strap buckled too tight or left too loose will render a horse uneasy in his harness, irritate his temper, set him plunging, and finally kicking and running away. This horse might have been a week since bought of a dealer, might have been driven in a double or single harness, have always gone perfectly quiet, and always would have done so if common judgment had been used. This is all we have a right to expect from a high spirited horse. He does not promise us to carry a phaeton or gig down hill on the top of his tail, or to be flayed alive by his harness from our carelessness."

The regular exercising of a horse is an exceedingly important part both of his training and of all his subsequent treatment. See the article Exercise. A saddle-horse who has been regularly exercised during the period of his training, will, if afterwards properly treated, always perform his work with ease and pleasure; while one who has been fitfully exercised, or alternately overdone and neglected, will come from the breaker's hands either with windgalls, splints, or other forms of chronic disease, or with an enfeebled constitution and a morbid susceptibility of inflammation and other acute disorders. A properly trained and ordinarily strong farm-horse has, for the most part, regular, full, and healthy exercise in the simple performance of his daily work; he neither suffers worrying exhaustion, nor stiffens and stagnates from inactivity, nor contracts predisposition to either chronic or acute disease; and, when moderately well-fed and otherwise well managed, he enjoys a degree of both healthiness and longevity which is rarely witnessed in any of the kinds of either saddle or carriage horses. But the occasionally worked saddle-horse, even though he should have been thoroughly well trained, can be maintained in tolerable vigour, or kept free from a morbific condition, or preserved in life and activity through a moderate series of years, only by means of daily, judicious, artificial exercise. All idle and neglected horses are more or less enfeebled and diseased; and even horses who stand inactive during only a very few days and then pass into a short continuance of violent exertion, or make an ordinarily long and not very rapid journey, are very liable to inflammations or other dangerous acute disorders. "How often, nevertheless, does it happen," exclaims Youatt, "that the horse which has stood inactive three or four days, is ridden or driven thirty or forty miles in the course of a single day! This rest is often purposely given to prepare for extra exertion,—to lay in a stock of strength for the performance of the task reqnired of him; and then the owner is surprised and dissatisfied if the animal is fairly knocked up, or possibly becomes seriously ill. Nothing is so common and so preposterous, as for a person to buy a horse from a dealer's stable, where he has been idly fattening for sale for many a day, and immediately to give him a long run after the hounds, and then to complain bitterly, and think that he has been imposed upon, if the animal is exhausted before the end of the chase, or is compelled to be led home suffering from violent inflammation. Regular and gradually increased exercise would have made the same horse appear a treasure to his owner." A young horse requires more exercise than an old one; yet a very young one ought not to have either very prolonged or very fatiguing exercise. A well-fed horse, also, requires more exercise than an ill-fed one, and ought to have it during an hour each time twice a-day, or at least during an hour and a half once a-day. A saddle-horse, especially if he possess much blood and high spirit, ought, when exercised, to be first walked for a considerable distance, next gently trotted, sometimes next briefly galloped, and always finally reduced down to walking, and taken home in a cooled and unexcited state after his exertion. The practice of galloping a horse for an hour, and then taking him to the stable in a state of profuse perspiration, is always more or less injurious, and sometimes entails almost as bad consequences as a serious degree of inertion and neglect.

In Egypt and Arabia, horses are usually watered but once a day; in Persia, they are watered at sunrise and at sunset; and in Britain, they are pretty generally watered thrice a-day. Spring water, partly from its coldness and partly from its want of saline admixture, is injurious to most horses; and river or pond water, even though it should be muddy and warmish, and should contain but a very diminutive proportion of carbonic acid, agrees well with almost all horses. The regularly-worked and healthily-conditioned draught horses of a farm, usually drink their fill at some pond or streamlet adjacent to the farmery, without almost ever experiencing any bad effect; while hunters, hackneys, and other horses kept entirely for the saddle, are commonly stinted or controlled in their drink, and yet not unfrequently suffer from it very serious consequences. When pump water or other spring water must be used, it ought to stand in the trough or pail, exposed to the air or to the sunshine, for a sufficient length of time to let it acquire nearly as high a temperature as that of the surrounding atmosphere; but the soft-water of a brook or a pond, and most of all the water of a pond or brook to which the horses have been accustomed, ought always to be preferred. A prejudice exists in most persons against the unrestricted permission of water to saddle-horses; and this, in the case of racers and hunters, usually rises so high as to stint them of water for a day or two before running, and to allow them none whatever on the day of action. But though the watering of a horse immediately before he is galloped, may certainly do serious and irreparable mischief to his respiratory organs, the limitation of his drink in other respects makes him fidgetty and unhappy, retards or embarrasses some of his functional secretions, and powerfully predisposes him to violent spasms, sudden inflammations, or some other forms of very dangerous acute disease from the occasional indulgence of an insatiable thirst. A horse who has frequent access to water, and is allowed the uncontrolled use of it, really drinks less in the course of a week than a horse who has access to it only under some restraints, and who, whenever he touches it, gulps it down like a vortex and looks as if he would annihilate the stream. The stinting of water to any horse is both great cruelty and very bad policy. Every working horse ought to be liberally watered thrice a-day, especially in summer,—and then he will be free from the tortures of thirst, and will have due liveliness and perseverance in his work, and will escape liability to many pains and diseases; and every hackney, while on a journey ought to be liberally watered thrice or four times every day,—first waiting till he has somewhat cooled, then receiving two or three quarts of water, then his feed, and then another draught of water.

The necessity of giving to all domestic animals such food as contains a due proportion of nitrogenous principles, the economy and prudence of accompanying the feeding of all the domestic animals with a comfortable degree of external warmth by shelter, the propriety of adapting the food of horses to different breeds and different temperaments, and an outline of suitable dietary treatment of horses throughout the successive seasons of the year, have been noticed in the article FEEDING OF ANIMALS. Yet four important points in the feeding of horses remain to be here discussed,—the bad effects of over-feeding, the benefits of the system of manger-feeding, the proper allowances and mixtures of articles of food, and the proportioning of the amount of nourishment to the size, age, and work of individuals.

No horse ought to be over-fed or to have an unlimited allowance of highly or even considerably nutritious food. The packing of a horse with as much food as he can take, under the mistaken notion either of kindness to the animal or of its enabling him to perform a maximum of work, not only wastes the food and does the horse no real good, but injures his constitution, and predisposes him to many dangerous inflammatory diseases. His stomach, when unduly full, presses upon the diaphragm, diminishes the surrounding area of the chest, encumbers the oxygenizing action of the lungs, impedes the heart's power of propelling the blood with sufficient velocity through the various textures of the body, and, in consequence, diminishes the energy of the whole system, induces a lethargic and somnolent tendency in the functions of the brain, dilutes the strength and vitality of all the secretions which are immediately dependent on the circulation, and occasions the formation and deposition of fatty matter in lieu of some of the requisite renovation of muscle. The repletion of the stomach, also, weakens its mechanical action in consequence of excessive distension, enfeebles its secretive power in consequence of an overload of matter, and makes an exorbitant demand upon its gastric juice in consequence of the enormous scope afforded for the decomposition of the proximate principles of nutrition. All food, like all other dead organic matter, has a tendency to resolve itself into its elements; it encounters a thorough resistance of this tendency, so as to pass into actual nourishment, partly by the direct reducing action of the stomach, and partly by the antiseptic power of the peculiar gastric secretion called the gastric juice; and when it is swallowed in such quantity as not to be wholly reducible by the gastric action and completely saturated with the gastric juice, some portion of it is decomposed, and not only ceases to be food, but forms putrid and noxious combinations which irritate the intestines, and produce either actual disease or at least a morbific disposition. "So long as an animal experiences the sensation of hunger, the gastric juice is poured out from the coats of the stomach, in sufficient quantity to saturate the aliment that is swallowed; but that feeling once appeased, the secretion of the juice either ceases entirely, or its properties are so altered and weakened as to be no longer capable of offering due resistance to the putrefactive process. Thus, beyond a certain quantity, every mouthful of food, placed as it must be in the situation most likely to favour decomposition—namely, one of warmth and moisture,—speedily becomes a putrid mass, evolving a large quantity of noisome gas—as does every animal or vegetable substance in this state—by which distension is increased and acidity and irritation produced."

Continued repletion, therefore, produces direct diseases of the stomach, the intestines, and the circulatory system; it produces, in particular, prevailing costiveness, occasional diarrhœa, and continual feebleness of vital secretion; and it excites, or indirectly and slowly produces, many inflammatory affections, many chronic disorders, and almost all the morbid conditions of organ or function to which different breeds or constitutions may be liable,—in the viscera of one class of horses, in the brain of another, in the eyes of a third, and in the lungs or liver or other organs of a fourth. Even continued feeding, though neither the progress nor the aggregate of it should ever amount to actual repletion, is exceedingly injurious. The single and comparatively small stomach of a horse, just as really as that of a human being, requires long intervals of repose, and cannot, without serious damage, be kept constantly working upon a continuous supply of food. It performs its functions in a progressive or serial manner, first liberally secreting gastric juice in preparation for a meal, next saturating the materials of the meal with the gastric juice, and working them up into a homogeneous mass, and next comminutes successive portions of the mass into the fine pulp called chyme, and discharges them into the pylorus on their way to yield up their nourishing juices to the system; and only when it has conducted most part of a meal though the whole process, or has nearly finished the reduction of the whole mass into chyme, does it return to a vigorous secretion of more gastric juice, preparatory to the reception and saturation and digestion of the contents of another meal. See the article Chyme. Hence the alternate disrelish for food and keen hungering for it on the part of a healthy and regularly-feeding human being; and hence, too, the necessity, in both man and horse, of taking food in meals, and of completely abstaining from it during the whole of every interval between the meals. The effect of putting fresh food into the stomach before the previous meal has been digested, is either to excite the stomach to secrete fresh gastric juice and so overtax its powers, or to send the food in a decomposed or decomposing state into the intestines, and so produce irritation and disease.

Every horse, therefore, ought to receive at any one time only so much food as is sufficient to appease his hunger and maintain his strength, and never enough to overload his stomach or to leave a surplus for his after-use; and he ought, in all ordinary circumstances, to pass an interval of at least four hours between any two meals. A farmer should not only mete out the proper daily allowance of corn, beans, or other chiefly nutritious food for his horses, but prevent his men from giving them an unlimited, or constant, or unduly large supply of hay, herbage, or other fodder. Many a ploughman or carter, totally ignorant of the natural laws of a horse's digestion, and either to save himself the trouble of giving limited periodical supplies, or in order, as he supposes, to let the horse maintain a maximum of power by continually eating as much as he is able, crams the rack with hay or other fodder, and seldom or never allows it to be empty. The consequences are, that much of the fodder is pulled down, blown upon, and wasted,—that the horse acquires a mischievous and morbid habit of eating between meals,—and that, if he happen not to have a due allowance of corn or beans or other highly nutritious food, he always eats more hay than his comparatively small stomach can rightly contain, and entails upon himself all the disastrous effects of excessive gastric distension.

The system of manger-feeding is rapidly and generally superseding the use of the rack; it consists in mixing chaff or minutely cut hay or straw with oats or beans or other granular and highly nutritious substances, and giving the whole as manger-meat; and it possesses the twofold recommendation of preventing a waste of hay or other fodder, and of obliging horses somewhat thoroughly to masticate their oats and beans. See the articles CHAFF and CHAFF-CUTTER. Most horses pull down and trample and waste a portion of the fodder served to them in racks; and some cull out for their use only the sweetest locks, and pull down and trample to destruction so enormous a quantity as one-third or so of the whole. All horses, too, swallow some portion of their oats and beans in so imperfectly masticated a state as to void them unassimilated and almost entirely unaltered; and some hungry and greedy ones, partly from the urgency of excessive appetite and partly from the slovenliness of bad habit, scarcely masticate their oats and beans at all. "Many horses," remarks Professor Stuart, "swallow their corn in great haste, and when much is eaten, that habit is exceedingly dangerous. The stomach is filled—it is overloaded before it has time to make preparation for acting on its contents—the food ferments, and painful and dangerous colic ensues. By adding chaff to his corn, the horse must take more time to eat it, and time is given for the commencement of digestion, before fermentation can occur. In this way chaff is very useful, especially after long fasts." The horse finds the chaff too hard and pointed to be swallowable without considerable mastication; he cannot throw it down among his feet like unchaffed fodder; he is compelled, while masticating the chaff, to grind down the oats and beans with which it is mixed; and he fills his stomach more slowly than with unmixed oats or beans, and gives it greater time and scope for thoroughly saturating and macerating the food with gastric juice. Almost all horses are very fond of this mixed provender; and many of them, after having become accustomed to it, will, if an option be allowed to them, prefer it to the best mixed oats. Not only, too, have farmers found manger-feeding both a considerable saving of food and a material advantage to their teams; but some gentlemen, in spite of the resistance of their grooms or coachmen, have, with excellent effects, introduced it to their stables for their hackneys and carriage-horses. Manger-feeding may, in almost every instance, occasion too much distension of the stomach of the race-horse; and may, in any instance, be suitable for the hunting-horse, only when the quantity of the chaff, as compared to that of the corn, is very small; but it is well suited for most hackneys and carriage-horses, and admirably adapted for all kinds of horses of slow and heavy draught.

Yet even in manger-feeding, food must be given in meals and measured allowances, and never profusely dealt out on the assumption that a horse will not eat of it to excess. "The system of giving the whole of the food as manger-meat, under the impression that the horse will lie down and rest so soon as he has finished his meal, is in many cases liable to the objection that, even when satisfied, he will continue to eat for the purpose of getting the corn that is mixed with his food, and will then probably only lie down immediately from the feeling of oppression induced by repletion. When corn, beans, and chaff, in proper quantity and proportions, are given without the admixture of cut hay, if a horse have had enough, he will, unless a glutton, lie down perhaps at once, or will pull a small portion of hay from the rack before he does so, but will never leave the food that contains corn until he have eaten more than is good for him, and loathe the remainder."

The bruising of oats and beans and the steaming of chaff and esculent roots have, in many instances, been combined with manger-feeding, as means of assisting the digestion of the horse, and preventing the loss of nutritious portions of his food. Unbruised oats, when mixed with chaffed hay, are apt to slip out of it; but bruised oats and slightly wetted chaff thoroughly and pertinaciously retain their state of mutual intermixture. Seeds swallowed whole by either horses, large birds or other animals often pass through the stomach and intestines, not only unreduced and unassimilated, but in full retention of their vitality; so as to germinate quite as readily as if they had never been swallowed, or even to have their power of germination stimulated and strengthened by the action of the animal heat of the intestines and the chemical agencies of the excrement. The bruising of oats and beans, therefore, besides rendering them thoroughly miscible with the chaff, and occasioning them to be eaten in uniform proportions with it, prepares them for assimilation by destroying their vitality, and assists their digestibility by multiplying the extent of surface which they present to the action of the stomach. Bruised oats, indeed, are supposed by many persons to have a laxative effect upon horses; but they really have no such effect upon almost any horses of slow and heavy draught, or even upon the great majority of horses of lighter structure; and in any instances in which they might act laxatively if given alone, they do not so act when given in intermixture with a proper or corrective proportion of chaffed hay.

The steaming or boiling of chaff and esculent roots, and even of the whole mass of any kind of manger-meat, is recommended by some eminent veterinarians, on account of its bringing the food into the fittest possible state for digestion and assimilation, and by many distinguished agriculturists on account of its observed efficacy in promoting the ultimate objects of feeding. "If," says Professor Dick, after describing the process of digestion and incipient assimilation, from the act of deglutition on to the formation of chyle, and the absorption of it by the lacteals—"If the hardest of the food must, in this manner, be broken down and dissolved before it can really enter into the system, it must appear evident that something approaching to this solution, if done artificially, would greatly aid the organs of digestion in this process, and that thereby much exertion might be saved to the system, and at the same time, nourishment would be more rapidly conveyed into it. It is with this view that I would recommend the general adoption of cooking food for horses. When the food is broken down by cutting the hay and straw, and bruising, boiling or steaming the oats, not only is there less waste, by the whole being used as manger-meat, but much labour is saved to the animal, in having the tough dried hay, and hard oats, masticated for him, and in a state almost prepared for digestion; and, as regards the oats, all the nourishment they can afford is readily yielded to the digestive organs." "As respects the boiling or steaming of food," says Goodrich Smith, "its importance is seen from the fact, that 'it takes a horse from three to four hours to masticate one stone of hay, but a mash of potatoes of double that weight may be eaten in 40 minutes.' Potatoes, it is said, lose about one-eighth of their weight by the evaporation of the water when steamed, or about one-sixth if kiln dried or baked. It is even said that it has been ascertained, that a bushel of oats boiled will maintain a horse in better condition than two in the common way." See the articles BOILING and STEAMING.

Manger-feeding, however, whether with raw or with cooked food, must not be so practised as to exclude other kinds of feeding, in all conditions of the horse or at all seasons of the year. Its main proper use, exclusive of other feeding, is during the winter for healthy horses, and while they are employed either constantly or often at hard work. The sick horse may, at any season, have hay or tares or other dry or green fodder in the rack; the slightly worked horse may occasionally, in winter, have a portion of hay or roots in lieu of the more nutrient manger-meat; and the healthy and hard-working horse may, in summer, receive manger-meat only during the day-time of his periods of hard labour, and be turned out to grass during every night and every rest-day, or be, to a large or even principal amount, fed with lucern or other similarly nourishing green food. See the articles CALENDAR, FOOD, and FEEDING OF ANIMALS.

The proper allowance of food for horses varies according to the constituents of the food, the condition in which they are used, the season of the year, and the particular character, weight, health, and work of the horses; and it has been somewhat diversifiedly estimated both on the ground of experiment, and on that of appeal to scientific principles. Mr. Stevenson of Redside in East Lothian, records, in a recent Prize Essay in the Highland Society's Transactions, a judiciously instituted and well-conducted experiment on farm horses, from November till August, during which three were fed daily with each 42 lbs. of Swedish turnips and 15 lbs. of bruised oats,—two with each 42 lbs. of Swedish turnips and 15 lbs. of a mixture of two parts of bruised oats, one part of bruised barley, and one part of bruised beans,—two with each the same as the preceding, except that the portion of the mixture for one of the three daily feeds was boiled and unbruised,—two with each the same as the preceding, except that the Swedish turnips and also the whole of the mixture were boiled,—and two with each about 150 lbs. of boiled Swedish turnips, and 5 lbs. of the bruised mixture. The first set jointly weighed on the 11th of March 297 stones, and on the 29th of April 282 stones; the second set, on the 11th of March 206 stones, and on the 29th of April 197 stones; two of the third set, on the 11th of March 181½ stones, and on the 29th of April 179 stones; the fourth set, on the 11th of March 166 stones, and on the 29th of April 155½ stones; and the fifth set, on the 11th of March 199½ stones, and on the 29th of April 189 stones. Two of the first set, who, on the 29th of April jointly weighed 208 stones, afterwards received each, in lieu of the turnips, a daily allowance of 4 lbs. of oil cakes and 5 lbs. of oats,—and jointly weighed on the 3d of August, 219½ stones; the second set received each, in lieu of the turnips, 4 lbs. of oil cakes and 5 lbs. of the mixture,—and jointly weighed, on the 3d of August, 208½ stones; the fourth set received each, in lieu of the turnips, 4 lbs. of oil cakes and an additional feed of the raw mixture, —and jointly weighed, on the 3d of August, 160 stones; and the fifth set received each, in lieu of the turnips, 4 lbs. of oil cakes and 5 lbs. of the mixture originally given to the third set,—and jointly weighed, on the 3d of August, 205 stones. Mr. Stevenson says, *inter alia*, "From November to March, the horses were all in good health. The quantity of grain consumed by each horse was evidently more than was requisite during the winter months for the labour performed, the girths having increased considerably. Those horses which were fed on bruised oats were evidently less energetic than the others: two of them performed less work—they were dull in the yoke, and their coats looked unhealthy. Those on raw mixed grain were the most energetic. Those on the boiled food, whether turnips or otherwise, showed a healthy glossy coat, their perspiration did not seem more abundant than usual, with the exception, perhaps, of those fed on boiled turnips. Those on boiled turnips consumed more straw; they scarcely ever tasted water. In regard to the article of cost, the results are in favour of the boiled turnips, with one feed of bruised grain."

Youatt thinks that, of a manger-meat mixture, of chaff, oats, and beans, in the proportion of twenty pounds of chaff, eight of oats, and two of beans, 34 or 36 pounds are a sufficient daily allowance for any moderate-sized heavy-draught horse with fair or even hard work, and 40 pounds for a dray or waggon horse. Thaer thinks that the daily allowance to a horse of middling height, when performing ordinary work, may be regarded as good when consisting of 8⅕ lbs. of hay and 9⅕ lbs. of oats. Goodrich Smith appears to recommend, as a proper daily allowance for 8 horses, one bushel of beans, one bushel of oats, and one bushel of chaffed hay and straw. Another authority mentions as a good allowance for a horse, 8 lbs. of bruised oats, 3 lbs. of bruised beans, and 4 lbs. of chaffed straw in the day, and 22 lbs. of steamed potatoes, 1½ lb. of fine barley dust, 2 lb. of chaffed straw, and 2 oz. of salt at night. Another estimates the proper daily allowance in winter at 15 lbs. of hay, 10 lbs. of straw, and 8 lbs. of oats, together with as much oatmeal or ryemeal as will thoroughly whiten a bucket of water after each feed. Another allowance consists of 5 lbs. of bruised oats, pease, or beans, 7 lbs. of chaffed hay, 5 lbs. of straw, 5 lbs. of steamed potatoes, and 6 lbs. of brewer's grains; another, of 5 lbs. of bruised oats, pease, or beans, 8 lbs. of chaffed hay, 10 lbs. of straw, 5 lbs. of steamed potatoes, and 2 lbs. of malt-dust or ground oil-cake; another, of 10 lbs. of bruised oats, pease, or beans, 10 lbs. of chaffed hay, and 10 lbs. of straw; and another, of 5 lbs. of bruised oats, pease, or beans, 8 lbs. of chaffed hay, 8 lbs. of straw, and 7 lbs. of bran. Mr. Curwen recommends for a farm horse 21 lbs. of steamed potatoes, 7 lbs. of steamed chaffed straw, 7 lbs. of long straw, and 8 lbs. of oats,—and for a colliery horse 8 lbs. of chaffed hay, 8 lbs. of chaffed straw, 7 lbs. of steamed potatoes, 6 lbs. of carrots, and 12 lbs. of oats; and he says, in reference to various approved practices of feeding with a combination of carrots and other food, "When from 8 to 12 lbs. of oats are allowed to a work-horse per day, according to its employment, 4 lbs. may be deducted for 5 lbs. of carrots, and the spirit, condition, and ability of the horse be improved by the same. * * Other accounts state a bushel of carrots to be given daily instead of oats. * * Horses are fed on carrots with sometimes hay and sometimes corn, and sometimes with only straw; as first, for 6 horses, two loads of 40 bushels per week, no corn, and little hay,—second, for 6 horses, one load, with corn in the spring-time, and little hay,—and third, for 6 horses, 72 bushels per week, no oats, and half the usual allowance of hay. * * In Surrey, where carrots are extensively cultivated, a team of 4 good horses get about 60 bushels per week until Christmas, with plenty of chaff or clover hay, but no corn, and after that 40 bushels are given with 2 bushels of oats and a sufficiency of chaff." Boussingault states that the usual allowance to his farm-horses at Bechelbronn consists of 22 lbs. of hay, 5½ lbs. of straw, and 7½ lbs. of oats; and he says, in connexion with a minute report of experiments which he made with a variety of mixed rations: "In the circumstances in which we are generally placed in this country, I do not imagine that there would be any actual advantage in replacing the ordinary food of our horses by roots and tubers; I doubt even whether the substitution would have good effects. I know, indeed, that horses have been kept through the winter upon potatoes and mangel-wurzel; but it is a different matter to feed an animal and keep him standing quiet in the stable without work, and to feed him at the same time that a certain quantity of labour is required of him every day. A horse in full work would scarcely get through the bulky ration, which should consist of beetroot alone; his meal times are restricted; if he has certain hours for his work, so has he certain hours for his breakfast, dinner, and supper also. This is one reason why carriers' horses and post horses,—horses in a word which have long and severe work to perform,—receive the larger portion of their allowance in corn."

Mr. Stephens, the author of the Book of the Farm, mentions that a large coach-proprietor in Edinburgh gives each of his coach-horses a daily allowance of 8 lbs. of chaffed straw and 16 lbs. of bruised oats, and that another person gives to each of his large horses 10 or 12 lbs. of chaffed straw and 16 lbs. of bruised oats. A common allowance, in well-conducted stables in England, consists of 11 lbs. of chaffed hay, 2⅕ lbs. of chaffed straw, 11 lbs. of oats, and 1⅒ lb. of beans. The ordinary allowance for a British cavalry horse in barrack consists of 12 lbs. of hay and 10 lbs. of oats. The allowance for each horse in the Municipal Guard of Paris for 1840, as also that for a troop horse in the reserve cavalry of France for some time previous to 1840, consisted of 11 lbs. of hay and 8 lbs. of oats, together with 11 lbs. of straw for litter; that for a troop horse in the French cavalry of the line, previous to 1840, consisted of 8⅘ lbs. of hay and 7½ lbs. of oats, together with 11 lbs. of straw for litter; and that for a troop horse of the light cavalry, previous to 1840, was the same as the preceding in hay and straw, but comprised only 6⅗ lbs. of oats. But, since 1840, the allowance for a horse of the reserve cavalry consists of 8⅘ lbs. of hay, 9⅕ lbs. of oats, and 11 lbs. of straw,—for a horse of the cavalry of the line, of 6⅗ lbs. of hay, 8⅘ lbs. of oats, and 11 lbs. of straw,—and for a horse of the light cavalry, of 6⅗ lbs. of hay, 8³⁄₁₀ lbs. of oats, and 11 lbs. of straw. "When the horse is fed on hay and oats," says Youatt, in reference particularly to the farm-horse, "the quantity of the oats must vary with his size and the work to be performed. In winter, 4 feeds, or from 10 to 14 pounds of oats in the day, will be a fair allowance for a horse of 15 hands 1 or 2 inches high, and that has moderate work. In summer, half the quantity with green food will be sufficient. Those who work on the farm have from 10 to 14 pounds, and the hunter from 12 to 16. * * When extra work is required from the animal, the system of management is often injudicious, for a double feed is put before him, and as soon as he has swallowed it, he is started. It would be far better to give him a double feed on the previous evening, which would be digested before he is wanted, and then he might set out in the morning after a very small portion of corn has been given to him, or perhaps only a little hay. One of the most successful methods of enabling a horse to get well through a long journey is to give him only a little at a time when on the road, and at night to indulge him with a double feed of corn and a full allowance of beans."

The relation between the height or weight of a horse and the quantity of provender which he requires, and also the relation between the feeding and the growth of foals, are topics of great economical interest, and require to be well ascertained before any enlightened principle or established law can supersede the conflicts of opinion and diversities of practice respecting horse-diet; and yet, so far as we are aware, some scanty experiments by Boussingault are the only scientific attempts which have hitherto been made to put them to the test. Seventeen horses and mares belonging to Boussingault, aged from 5 to 12 years, and working from 8 to 10 hours a-day, weighed together 18,190 lbs. and received each a daily allowance of provender equivalent to 33 lbs. of meadow hay; so that for every 100 lbs. of live weight in the horses, a quantity of food equal in nutritious value to $6\frac{7}{10}$ lbs. was daily consumed. The foals of mares of each from 960 to 1,100 lbs. weight, weighed each at birth from 110 to 113 lbs.; and during the three months of suckling, they each increased in weight to the aggregate amount of 278 per cent., or at the daily rate of very nearly $2\frac{1}{3}$ lbs.,—during some time after weaning, they either suffered an arrest in growth, or actually lost a small proportion of their weight,—during the time from the end of their first year to the end of their second year, they each increased in weight at the rate of about $1\frac{3}{10}$ lb. a-day,—during the latter part of their third year, they each acquired weight at the rate of something less than 1 lb. a-day,—and after the completion of their third year, the period at which they very nearly attained their full development, they gradually ceased to make any perceptible increase. "I also," says Boussingault, "made a few experiments with reference to the quantity of provender consumed by foals in the most active period of their growth, and found that three, which weighed together 1,106 lbs., consumed per day $19\frac{4}{5}$ lbs. of hay and 7 lbs. of oats. The mean weight of these foals was 368·6 lbs., so that the hay consumed for every 100 lbs. of live weight was 2·85 lbs., with which allowance the daily increase amounted to about 1·2 lb., consequently a mixed provender, equivalent to 100 lbs. of hay had produced 12 lbs. of live weight. I must confess that this result appears to be somewhat too favourable, but I can only set down the numbers as they presented themselves to me."—*Cuvier's Animal Kingdom.—Jardine's Naturalist's Library.—Berenger on Horsemanship.—Low's Domestic Animals of the British Islands.—Bell's History of British Quadrupeds.—Hookham's Comparative View of the English Racer and Saddle-Horse.—Bohn's Pictorial Gallery of English Race-Horses.—Williamson's Wild Sports of the East.—Burne's Travels.—Bruce's Travels.—Burckhardt's Travels.—Culley on Live Stock.—Stewart's Stable Economy.—Longman's Stable Talk.—The Veterinarian.—Goodrich Smith's Economy of Farming.—Hall's Journey to Peru.—Youatt on the Horse.—Winter's Horse in Health and Disease.—Blaine's Veterinary Art.—Boussingault's Rural Economy.—Knowledge Society's British Husbandry.—Transactions of the Highland Society.—John Burke, Esq. in the Journal of the Royal Agricultural Society of England.—Professor Dick, James Wilson, Esq. and others in the Quarterly Journal of Agriculture.—Doyle's Practical Husbandry.—Stephens' Book of the Farm.—Marshall's County Reports.—The Edinburgh Encyclopædia.*

HORSE-CHESTNUT. See Æsculus.

HORSE-DEALER. A person who, in the way of ordinary trade, buys and sells horses. He pays an annual tax of £25 if he reside in the metropolis, or of £12 10s. if he reside in any other part of Great Britain; and he is bound by law to keep a record of every horse whom he has for sale, to make this record accessible at any reasonable time to the inspection of the proper officers, and to deliver a copy of it every quarter to the assessor of his parish. The metropolis has nearly an hundred regular horse-dealers; and the rest of Britain has probably upwards of a thousand.

HORSE-DUNG. See Excrement and Farm-Yard Manure.

HORSE-FENNEL. See Hippomarathrum.

HORSE-FLIES,—scientifically *Tabanidæ*. A family of comparatively large, blood-sucking insects of the dipterous order. They attack several large animals, particularly the horse and the ruminants, and sometimes man himself, for the purpose of feeding upon their blood; and they are provided, for this purpose, with a salient proboscis, so constructed as to perform the double office of a lancet to pierce the skin, and a tube to convey the fluid. The proboscis is usually terminated by two lips with projecting palpi, by the last joint of the antennæ being annulated, and by a sucker composed of six pieces. The flies are strong and robust; and one species, *Tabanus bovinus*, is one of the largest dipterous insects in Europe. Their eyes are exceedingly brilliant, and frequently adorned with rays and spots of crimson and purple; but their other parts are prevailingly dull and obscure in colour. They appear in June, but seldom become consummately mischievous till the middle of autumn; they abound more in the south of England than in Scotland; they delight in warmth and sultriness of weather, and are most active and insatiable at the very hours when cattle are least able to bear their

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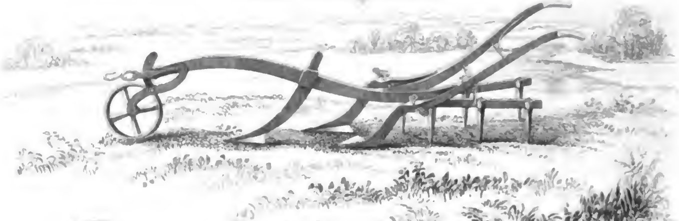
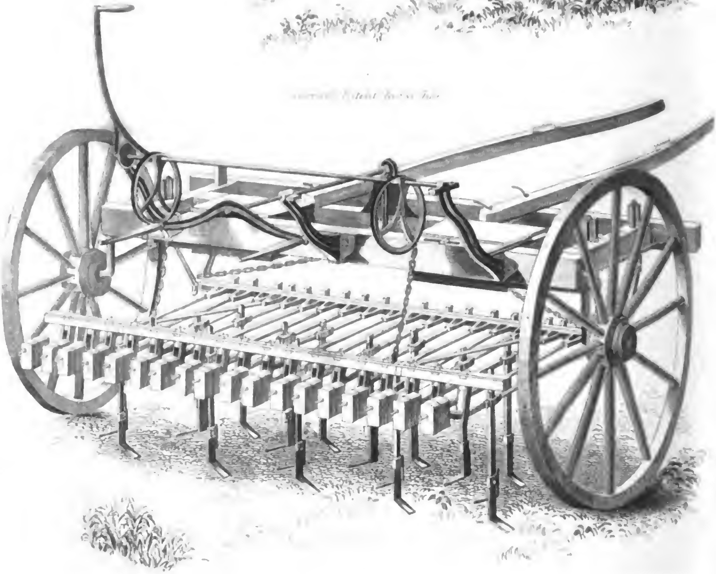
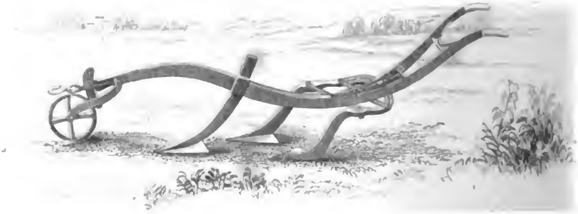
Wilkie's horse hoe and drill harrow



Garrett's Patent Horse Hoe



Wilkie's horse hoe with parallel motion



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attacks; and they are specially voracious and determined when the atmosphere, as frequently happens after a thunder-burst, is in both a sultry and a humid state.—They make a humming sound while on the wing; they extract so great a quantity of blood as to distend their bodies with it much beyond their usual dimensions; and some species enfeeble and almost madden several kinds of ruminants with their attacks, while others assail only one species of animal, and are somewhat measured in their ferocity. The females, however, are the chief or perhaps the sole blood-suckers; and the males live principally, or perhaps solely, on the juices of flowers. Five genera are comprised in the family; and the two most conspicuous British species, the horse-cleg and the cattle cleg, are described in our article Cleg.

HORSE-HOE. A horse-drawn implement for stirring the soil and destroying the weeds in the intervals of the drills of growing field-crops. It was first invented by the celebrated Jethro Tull; and, in consequence of its being the characteristic tillage implement of all the after-culture of drilled crops, it long gave the name of horse-hoeing husbandry to the system which Tull introduced of raising field-crops in drills. See the article Drill-Husbandry. The modes and uses of hoeing, whether with the hand-hoe or the horse-hoe, are noticed in the article Hoe; and the principal advantages of the horse-hoe over the hand-hoe, are rapidity of performance and economy of labour. "Expedition," remarks Blaikie, "is a most material point in all processes of husbandry, carried on in a variable and uncertain climate; and it frequently happens, that hoeing in any way can only be executed to advantage in a very few days in spring. Hence, the horse-hoe has a most decided advantage over the hand-hoe; for a man will only hoe about half an acre a-day with the latter, while, with the former, a man and a boy, with one horse, will hoe 8 or 10 acres a-day, and that in a more effectual manner."

The original horse-hoe, or that invented by Tull himself, was a rude implement, and resembled a roughly-shaped swing-plough, wanting the mould-board, and with the cutting-edge of the share turned up on its land-side. Subsequent horse-hoes, though less rude and sometimes displaying considerable ingenuity, continued to be very simple; and possessed some resemblance, either to a swing-plough without the mould-board, or to the scuffler, the scarifier, or the old, simple, and diminutive varieties of the grubber. Modern horse-hoes are exceedingly diversified in both structure and adaptation; they range between great simplicity and very considerable complexity; they vary widely from one another, both in the facilities with which they are worked, and the precise soils, crops, and conditions for which they are most suitable; and even such as possess a sameness of both general structure and special adaptation are considerably diversified by the caprice or the conflicting judgments of different manufacturers. Their comparative merits, as regards mere construction, will best appear from a separate description of each and a successive view of all; and their comparative value, as regards the circumstances in which they are to be used, is altogether relative, and depends, in a main degree, on the character of soil to be hoed, and on the best method of hoeing it. "Soils of different textures require to be hoed with shares of different forms, according to their hardness, or mixture of stones, flints or gravel. The number of hoes also in hard soils requires to be diminished; in the case of a strong clay, one hoe or flat share, with or without one or two coulters or prongs, will often be all that can be made to enter the ground. In using these implements, the operator should always consider whether he will produce most benefit by merely cutting over or rooting up the weeds, or by stirring the soil; because the hoe suited for the one purpose is by no means well adapted for the other. In the former case flat shares are to be preferred, but pointed, that they may enter the soil easily; in the latter, coulters or prongs, as in the cultivators, are much more effective, as they will enter the soil and stir it to a considerable depth, thus greatly benefiting the plants by the admission of air, heat, dews, and rains, and by rendering it more permeable by the roots."—[Loudon's Encyclopædia of Agriculture.]

Wilkie's horse-hoe and drill-harrow, or Wilkie's drill-grubber with appended harrow, is a very efficient implement both for cleaning and pulverizing the intervals of the drills as soon as the plants appear above ground, and for performing all the subsequent hoeing operations of ordinary after-culture. It was invented by the elder Wilkie of Uddingstone, and brought to quite or very nearly the state in which it is still made, between the years 1818 and 1821. It has somewhat the form of a plough; and consists of a beam, three coulters attached to the body and wings of the beam, a small wheel at the point of the beam, directing handles like those of a plough, and a harrow behind the coulters and below the anterior middle parts of the handles. The wheel at the point of the beam regulates the depth of the implement's action, serves as a fulcrum when the implement is raised to free the coulters from an accumulation of weeds, and facilitates the turning of the implement at the ends of the ridges. The foremost coulter has a double-feathered sole, passes up through a hole in the beam, and admits of being raised or lowered so as to be adapted to the precise depth of action required in the centre of the drill; the other two shares have single-feathered soles, and are attached on a line with each other to the wings of the beam or lower part of the handles, and are prolonged and hinge-jointed at top so as to be capable of expansion and contraction; and while the foremost coulter cuts the weeds and stirs the soil in the centre of the interval between two drills, the other two coulters, acting horizontally as well as vertically, pare the soil from the sides and bottom. The harrow consists of two bars, each armed with three very long harrow-tines, and is capable both of depression and of expansion; and it serves as a very useful auxiliary to the action of the coulters, by displacing the weeds, bringing the weed-roots to the surface, and thoroughly stirring and pulverizing the soil. A representation of this implement is shown in *Fig.* 1, *Plate XXVIII.*

Wilkie's horse-hoe with parallel motion is an invention of the younger Wilkie of Uddingstone; it differs from the preceding, partly in wanting the harrow, but principally in the manner in which the two side-coulters are adjusted; and it possesses, in an eminent degree, the capacity of easy and efficient contraction or expansion of its side-coulters, to suit the different widths of drills. A representation of it is given in *Fig.* 3, *Plate XXVIII.* The horizontal arms of its side-coulters behind their chief curvature are strongly jointed to the extremities of two cross-bars, which have their centres of motion in the beam; and in consequence of the arms and the cross-bars forming a parallelogram, the coulters, at whatever distance they may be set, constantly preserve a position equidistant from and parallel to each other, each uniformly advancing in the exact proportion in which the other recedes. The coulters, therefore, never suffer the inconvenience and comparative inefficiency, incident to those of many varieties of horse-hoe, of being thrown out of parallelism; and, being always at the greatest possible distance from each other, they also prevent, in the greatest practicable degree, a choking accumulation of weeds when the implement is working in narrow intervals.

The horse-hoe and double mould-board plough is an implement with a skeleton equally suitable for a proper horse-hoe and a proper double mould-board plough, and with such adjustments of the apparatus peculiar to each as to admit of that of the one being at any time easily substituted by that of the other. Both the horse-hoe of the elder Wilkie and the horse-hoe of the younger Wilkie, as originally made by their inventors, can be converted into double mould-board ploughs, for earthing up the soil on drills of turnips, potatoes, or other similarly growing crops, simply by the removal of the coulters of the latter, or of the coulters and harrow of the former, and by the affixation, in their stead, of a drill-body with mould-boards. The common double mould-board swing-plough, on the other hand, is often so constructed as to be convertible into a scuffling or cleaning plough, or virtually a quite efficient horse-hoe for any tolerably clean land, simply by withdrawing the hinge-pins of the mould-boards. It is usually made with a cast-iron body, and has its beam placed in the plane which bisects the angle of the handles; its mould-boards are jointed at the fore-part to the head, so as to be capable of expansion and contraction behind; it has a double-feathered share and two kneed coulters or scufflers set in jointed bars, which are adapted for variable widths; and it has no wheel. See the article Plough.

Finlayson's self-cleaning horse-hoe and drill-harrow may be conceived to bear nearly the same relation to both the horse-hoe of the elder Wilkie and that of the younger Wilkie, which Finlayson's patent harrow bears to Wilkie's grubber. See the article Grubber. It has a much more facile and efficient action on many kinds of soil than the Wilkie horse-hoes, and operates much more in the manner of a harrow than that of the younger Wilkie. Its tines are eight in number, fixed in a narrow skeleton frame, and all self-cleaning; and six are swan-necked and prong-pointed, while the two hindmost ones are curved and feather-soled. A beam projects from the front of the frame, and terminates in a fulcrum-wheel and the draught-attachment; and a pair of guiding-handles, exactly like those of a common plough, project from the rear of the frame.

Weir's expanding horse-hoe is somewhat similar in structure to the Wilkie horse-hoes; and is so made as to do the work either of a proper horse-hoe or of a double mould-board plough. It has circular coulters, hoe-tines, and a double mould-board; and when used as a horse-hoe, its curved coulters are adjusted into the expanding bar in adaptation to the width of the intervals to be hoed; and when used as a plough for earthing up potatoes or turnips, it is mounted with the mould-boards and a suitable coulter.

The common Scotch horse-hoe is a plough-grubber, carrying five coulters, and having the fore-part of its beam supported on a wheel, which regulates the depth of the coulters' action; and four of its coulters are set, two and two, in jointed bars, which contract and expand to suit the width of the interval between the drills. But another form of the common Scotch hoe has only three coulters, and is so constructed that, when required to work any hard soil, one or more of its ordinary coulters can be substituted by bent prongs.

Henry's improved scarifier is closely allied, at once in form, in action, and in uses, to a light grubber; and may be regarded as intermediate in character between a small form of the old scarifier and the Wilkie or Finlayson varieties of the modern horse-hoe. It has a triangular outline, and is mounted on three small wheels; its tines are nine in number, and have small duck-footed soles, — and are adjusted in two linear series,—four upon the front cross-bar and five upon the hind cross-bar; and its guiding handles are light, and project from the middle part of the frame.

Gorrie's drill-grubber or horse-hoe, was invented, in 1840, by Mr. Gorrie of Annat-Garden in Perthshire. It carries a scuffler in front, equal in length to the width of the intervals between the drills, and so disposed as to undercut all weeds; it has, behind the scuffler, such tines or coulters as throw the weeds at once to the surface; and it is furnished with a wheel under the beam, for the purpose of regulating the depth of the action.

Morton's horse-hoe was invented about 20 years ago by Mr. Morton of Edinburgh. It consists of directing handles somewhat similar to those of a plough,—two beams, which extend in continuation of the handles, and finally curve to a junction, and send off a projecting bar,—two tines upon the lower extremity of the handles, eight upon the two beams, and two upon the projecting bar,—and two cross-bars, adjusted transversely between the beams. The foremost tine upon the projecting bar is a cutting coulter; the hinder tine upon the projecting bar is a triangular-soled share; the eight tines upon the beams are straight, pointed teeth; and the two tines upon the lower extremity of the handles are triangular-soled shares. An apparatus exists within the construction to set the tines at any width which the distance between the drills may require; and the relative position and aggregate expanse of the soles of the three triangular-soled shares are such as to cut all weed-roots athwart the whole interval between the drills.

The Hawick horse-hoe is similar, in general structure, to Morton's horse-hoe; but is less elaborate in the combination of its parts, and has a smaller number and different form of tines. One triangular-soled share in front cuts all the weed-roots in the middle parts of the interval between the drills; and six curved-footed coulters, adjusted on the beams, cut all the weed-roots along the side-parts which escaped the action of the share. A joint at the fore-extremity of the right beam, and a simple contrivance in the transverse bar between the hind-extremity of the two beams, serve the purpose of expanding or contracting the implement to suit different widths of interval between drills.

Brodie's horse-hoe is of similar date to Morton's horse-hoe, and takes its name from Mr. Brodie of Templebar in the vicinity of Peebles, and is specially adapted to the prevailing character of soils in any very stony district. It consists of directing handles, like those of a plough,—a middle beam, formed by the convergence of the handles, and extending thence to the fore-extremity of the implement,—two side-beams, connected at their hinder end by a transverse bar, converging to a junction at their fore-end with the middle-beam, and combining with the transverse bar to give the body of the implement a triangular outline,—one straight and pointed tine on the fore-extremity of the middle beam,—four straight and pointed tines, and a fifth and inwardly curved-footed tine, on each of the side beams,—two short rods projecting from the transverse bar immediately below the handles, and each furnished at its extremity with a straight and pointed tine,—and an apparatus for expanding or contracting the body of the implement in adaptation to the width of intervals between drills. The nine straight tines in front stir and pulverize the soil of the greater part of the interval; the two inwardly curved-footed tines almost meet each other at the points, and cut up any root-weeds which escape the action of the other tines; and the two tines upon the backward-projecting rods spread or level the soil after it has been acted on by the curved-footed tines.

The Northumberland horse-hoe is of simple construction, and triangular form; it contains either six tines or three coulters and three tines, according to the state of the soil; and, when used for hoeing between rows of turnips, its two side coulters have a curved form. This implement is frequently used instead of a grubber in pulverizing land for barley in spring, and in tilling bean-stubbles in preparation for wheat in autumn; and a diminutive variety of it is sometimes attached to a small roller, and used for hoeing the intervals between drills of barley and wheat.

Blaikie's inverted horse-hoe was introduced by the author of the well-known Treatise on Farm-Yard Manure; and was the earliest efficient implement of its class for hoeing simultaneously the intervals between several drills of turnips; and possesses both singularity and simplicity of construction. Its tines are stalks or vertical bars, each terminating on one of its sides, in a small steel blade; they are fixed, at regular distances, into two parallel beams or bars of iron, the one of which is placed in advance of the other; those in the one bar have all their blades pointing to the right, while those in the other bar have all theirs pointing to the left; and the whole are so adjusted that, when the implement is in motion, the backs of each pair of stalks pass close to the plants in the drills, and the steel blades point to each other, and traverse all the soil of the interval between the stalks, and completely cut and till it without turning any of it upon the plants, or doing any injury to their roots. This implement is well-adapted for hoeing narrow intervals; and may, with both safety and efficiency, be employed either for drilled corn or for young turnips.

Lord Ducie's parallel expanding horse-hoe is constructed for hoeing drill crops, and at the same time is convertible into a light grubber by the simple means of taking out its hoeing-tines, and inserting a set of grubbing-tines with which it is accompanied. Its main part consists principally of a five-beamed or five-barred frame, and five strong, heavy, forward-curved, double-feathered shares,—mostly of cast-iron, but the cutting edges of the shares of hardened steel; and its other parts are handles to hold and steady it with, a tiller in front for the attachment of the draught, and a small wheel in front for regulating the depth of the action. It is sometimes made with only three tines instead of five; and it can be very facilely adjusted to any width from 12 to 27 inches, simply by moving the small pin into different holes made for the purpose in the side of the main-beam; and in consequence of the supports of the tines always moving parallelly with the beam, the share of each tine always presents its edge in a straight line to what it has to cut.

Grant's horse-hoes display considerable ingenuity, and possess much adaptation and efficiency. Grant's common horse-hoe is made entirely of wrought iron; and consists of guiding handles, a beam, a frame, angular-footed shares, a front wheel, and a hind wheel. "Mortices are made through the beam to receive two iron bars, upon which the frames supporting the shares may be adjusted to cut any given width, or at any desired interval; and by substituting mould-boards in the place of the wrought-iron frame for the shares, the implement is converted into a moulding plough." Grant's improved lever horse-hoe has a series of tines so adjusted on a frame, and each one of the series so commanded by a separate lever-power, that, by means of a compound lever, similar to that of Grant's patent-lever horse-rake, all the shares can be simultaneously elevated and instantly freed from an accumulation of weeds or rubbish. See the article Hay-Rake.

Howard's horse-hoe is a very simple but effective implement for the after-culture of turnips and drilled pulse. It has two rows of tines, with wheels working at an equal distance from each row; and it in consequence has a steady movement, and maintains a uniform depth. Its tines are very narrow, and in the form of spuds, and leave the soil in a much finer state than if broader tines were used; and their stalks are placed in an oblique position so as to allow the weeds to slide freely up, and to prevent accumulations of soil and rubbish from falling over upon the young plants. The tines and wheels contract or expand on the frame so as to suit different widths of intervals.

Amos's expanding horse-hoe and harrow is a much inferior implement to several of those which we have noticed; yet is said to be extensively used in Lincolnshire. It has a beam and a front wheel; its shares are expanding, and can be adjusted to any width of interval between drills, from 12 to 30 inches; and its harrow, not only serves as an useful appendage in the proper work of drill-hoeing, but possesses a sufficiency of action in cleaning land from successive gatherings of weeds, and in bringing soil into a state of reduced pulverulence and tilth, to adapt the implement, in a considerable degree, to the purposes of a grubber in the process of fallowing.

Clarke's universal ridge horse-hoe was invented by John Clarke of Long Sutton; and received the silver medal at the first meeting of the English Agricultural Society; and possesses ingenious adaptations for the purposes severally of a horse-hoe, a double tom, a moulding-plough, and a broad-share or cleaning plough, so as to perform all the various operations of ridge culture. A pointed, broad-soled share attached to the frame, completely hoes the furrow or central part of the interval between two drills; a moveable jointed frame, which can readily be adjusted to any desired width, is affixed to the beam, to receive the side-tines for hoeing; and two curved-footed tines are fastened into this when the implement is required to hoe plants upon the ridge,—and two flat-footed tines, when it is required to perform flat work. A small wheel, upon a vertical stem, poises the front of the beam, and regulates the depth of the action.

White's double-action turnip-hoe and Huckvale's patent turnip-hoe perform the after-culture of turnips, whether sown broadcast, in the drill, or on the ridge. "In addition to the hoes intended to pass in the direction of the ridge or furrow, or between the rows of the plants, White's implement is furnished with an apparatus which, by means of a crank put in motion by the fore-wheels, two hoes are made to traverse the rows, and thus to cut out the plants when it is desired to thin them on the row. It admits of adjustment to suit rows of any distance, from 15 to 30 inches wide; and the cross-hoes may be made to operate so as to leave the plants on the rows at distances of either 9, 12, or 15 inches apart. It may be used with one man and one horse; and by the substitution of spear-footed tines in the place of the hoes, it becomes an efficient light scarifier. Huckvale's patent turnip-hoe is intended to accomplish a similar operation to White's implement; but the hoes for cutting out the turnips on the rows, are, by a simple arrangement of two cogged wheels, made to revolve in the direction across the ridge, while the body of the implement, containing the hoes for cleaning between the rows, is drawn forward by a horse." [Ransome's Implements of Agriculture.]

Wilson's drill-grubber or horse-hoe was invented by Mr. James Wilson of Traprain in East Lothian, and is intended for cleaning the ground between the rows of drilled corn-crops. Its outer frame consists of timber, and is a variable parallelogram, and measures over all about 4½ feet in breadth and 3½ feet in length, and is supported in front on two wheels of about 20 inches in height, whose axles are bolted to the lower side of the front-bar. The hind-bar has affixed to its middle part a pair of directing handles, for the guiding of the implement, and so formed as to suit the height of the workman; the front-bar has affixed to it the draught-attachment; and the two side-bars are attached to the hind-bar by a mortice-joint and loose tenon, admitting of motion in a horizontal direction,—and to the front-bar by a hook-and-eye joint, allowing a considerable freedom of motion in every direction. Five bars for sustaining the coulters extend from the hind-bar to the front-bar; they are connected with the front-bar, each by means of a bolt which is immoveable in the coulter-bar, but slides up and down the hole pierced for it through the hind-bar, so as to allow the hind end of the coulter-bar to rise and fall; and they are attached to the front-bar each by a species of double hinge, which has one joint moving vertically and the other horizontally, so as to combine with the mobility of the side-bars to give a certain degree of universal motion; and a slight spring is attached to each of the coulter-bars, and adjusted to act against the lower side of the hind-bar, so as to keep the coulter at the greatest depression. The coulters are pointed and broad-footed shares, and are fitted to mortices in the coulter-bars at points about one-third of the total length of these bars from the hind-bar, and are fixed by wedges at the required height. A wheel of about 6 inches in diameter is attached by a vertical stem to each coulter-bar between the coulter and the front-bar, and serves to regulate the depth of the coulter's action. "From the form and description of the machine," says the Report of it in the Highland Society's Transactions, "it is easy to see that it must be made to dress either the same, or half, or any other aliquot part, of the original number of rows performed with the sowing-machine, by which the crop has been sown; and the intervals must be the same in both. The utility of the universal motion in the coulter-bars and frame will also be apparent; the horizontal motion of the whole allowing the director to follow any sinuosity that may have occurred in the operation of sowing, where all the rows sown at one time must be parallel, though they may not be in perfectly straight lines. The vertical motion of the coulter-bars, at the same time, allows any individual bar to rise when its coulter happens to meet with any obstacle, and so to pass over it without affecting the position of the others."

Garrett's patent horse-hoe was invented by Garrett & Son of Leiston; and it received prizes at the English Agricultural Society's meetings at Liverpool in 1841, and at Bristol in 1842, and the honorary medal at Derby in 1843, also East Norfolk in 1842, and West Norfolk in 1843. A representation of it is given in *Fig.* 2, *Plate XXVIII.* "This implement," says the report of it in the Journal of the Royal Agricultural Society of England, and in the Annual Register of Agricultural Implements, "is so complete in itself as to be fully suited to all methods of drill-cultivation, whether broad, stetch or ridge ploughing; and is adapted to hoeing corn of all sorts, as well as roots. The peculiar advantages of this implement are as follow:—It may be increased or diminished in size to suit all lands or methods of planting; the axletree being moveable at both ends, either wheels may be expanded or contracted, so as always to be kept between the rows of the plants. The shafts are readily altered and put to any part of the frame, so that the horses may either walk in the furrow, or in any direction to avoid injury to the crop. Each hoe works on a lever independent of the others, so that no part of the surface to be cut, however uneven, can escape; and in order to accommodate this implement for the consolidated earth of the wheat crop, and also the more loosened top of spring corn, roots, &c., the hoes are pressed in by different weights being hung upon each lever, and adjusted by keys or chains to prevent them going beyond the proper depth. What has hitherto been an insuperable objection to the general use of the horse-hoe, is over-ruled in this by the novel and easy method of steering, so that the hoes may be guided to the greatest nicety, if common caution be used, doing every execution among the weeds, without injury to the crop. This implement is so constructed that the hoes may be set to any width from 7 inches to any wider space. For the purpose of hoeing all kinds of corn, the inverted hoes only are preferred; but for the root crops, where the rows of plants are wider (say 16 inches or more), an extra hoe of a semicircular form is placed on a separate lever, working between and in advance of the two inverted hoes, for the more effectually cutting all the land, however uneven the surface, by the three separate hoes working independently of each other between the rows. The hoes are of peculiar improved manufacture, the blades being of steel, and made separate, and attached to a socket handle in a simple and easy yet effectual manner, so that any husbandman may replace them; and being manufactured by the patentees at an exceedingly low price, no difficulty can arise in replacing those parts subject to wear. In order to set the hoes in a proper cutting position for either flat or stetch ploughing, and so as thoroughly to cut either hard or soft ground, the levers are put into a more or less oblique position, causing the cutting edges of the hoes to be more or less inclining downwards, by raising or lowering the jointed irons to which the forward ends of the levers are suspended and swung, which is done by merely moving the pin which rests upon the frame into different holes."

The hoe-scythe or thistle-hoe was invented by Amos, and is designed to cut over thistles and other strong and injurious weeds in pasture-lands. It seems to be suitable only for a district in which agricultural practice is in a semi-barbarous condition; and even were it introduced to foul pastures in a good district, it can scarcely be so efficient as the ordinary practice of subduing thistles and similar weeds with the spade or spud. Yet its inventor speaks highly of its powers, and says that it performs its work both in a much closer manner and at greatly less expense than can be done with the scythe. A man and a horse, with this machine, are said to be able to cut over 20 acres in a day. The body of this implement has a triangular outline; and is furnished with a leading share upon its apex, and with two scythes upon each of its two sides. The leading share consists of cast-steel, and has the form of an isosceles triangle, of 12 inches in the base, and 14 inches in each of the two sides; and is about one-eighth of an inch thick in the middle, and thins off to a keen edge at the sides. Each scythe consists of cast steel; and measures 3 feet from point to point and 4 inches in breadth at the broadest part; and is fixed to a piece of ash timber, 3 inches square, and 28 inches long; and the four scythes, with their ashen attachments, are so adjusted upon the frame of the implement, as to form continuous lines with the cutting-edges of the leading share, and to flank nearly the whole of the implement's two exterior sides.—*Catalogue of the Highland Society's Museum.—Transactions of the Highland Society.—Quarterly Journal of Agriculture.—Journal of the Royal Agricultural Society of England.—Annual Register of Agricultural Implements.—Ransome's Implements of Agriculture.—Slight's Descriptions of Implements in Stephens' Book of the Farm.—Loudon's Encyclopædia of Agriculture.*

HORSE-LOUSE. See Louse and Lousiness.

HORSE-MINT. See Mint.

HORSE-POND. A pond for horses to drink in. The horse-pond of a farm ought to be in the immediate vicinity of the farmery. A substitute for it—far preferable to anything of a less natural kind—is a low-banked sweep or ford of a river, just deep enough to reach to the horses' knees. But where this, or some other and similar natural provision, does not exist, a pond must be made either by scooping out a basin in the course of a brook or rill, or by making a thoroughly artificial excavation, puddling it, flooring or paving it, and supplying it with water from a pipe or fountain. The quality of the water proper for a horse-pond is noticed in the section of the article Horse, which treats of the management of horses. The pond itself should be long, and should have only one side open, and should be traversed from end to end by a sufficient current to keep its water fresh and sweet. No watering-place for horses ought to have depth enough to reach their belly, and still less their sides; for though lazy ploughmen and grooms are fond enough of being saved some trouble in cleaning by wading the horses deep, the horses themselves, especially when fresh from work and on their way to the stable, are liable to injury from going any deeper than to their knees.

HORSE-POPPY. See Hippomarathrum.

HORSE-POWER. A horse's power of draught or carriage, of course, diminishes as his speed increases. The proportion of diminution, according to Professor Leslie, is as follows:—If we represent his force when moving at the rate of 2 miles an hour by the number 100, his force at 3 miles per hour will be 81; at 4 miles, 64; at 5 miles, 49; at 6 miles, 36; which results agree pretty nearly with the observations of Mr. Wood in his Treatise on Railroads, page 239. At his height of speed, of course, he can carry only his own weight. A horse draws to the greatest advantage when the line of draught inclines a little upwards. Desaguliers and Smeaton consider the force of one horse equal to that of five men, but writers differ on this subject. The measure of a horse's power, as the standard of the power of machinery, given by Mr. Watt, is, that he can raise a weight of 33,000 pounds to the height of one foot in a minute. Care should be taken, when a horse draws in a mill, or an engine of any kind in which he moves in a circle, that the circle be large; for, since he pulls obliquely, and advances sideways as well as forwards, his fatigue is greater as the circle is smaller. In some ferry-boats and machinery, horses are placed on a revolving platform, which passes backward by the pressure of their feet as they pull forward against a fixed resistance, so that they propel the machinery without moving from their place. A horse may act within still narrower limits, if he stands on the circumference of a large vertical wheel, or on a bridge supported by endless chains, which pass round two drums, and are otherwise supported by friction wheels. Various other modes of applying the force of animals are practised, but most of them are attended with great loss of power, either from friction or from the unfavourable position of the animal.

HORSE-RACING. See Horse and Racing.

HORSE-RADISH,—botanically *Cochlearia Armoracia.* A fusiform-rooted, cultivated, hardy, herbaceous plant, of the scurvy-grass genus of crucifers. It grows wild in waste grounds and moist situations in many parts of England; it has long been cultivated in gardens, for the sake of the condimental accompaniment of its roots to roast-beef; it has of late years been somewhat extensively cultivated in the fields, in some parts of England, for the sake of yielding from its roots an extract which preserves mustard ready-made for the table, and qualifies it for exportation to the East and the West Indies; and it has a place in the pharmacopœias of London Edinburgh, and Dublin, for the sake of the internally stimulating, diaphoretic, and diuretic, and the externally rubefacient properties of its roots. Its root is long, tapering, thick, fleshy, and whitish; its stem is straight, cylindrical, branched, and about 3 feet high; its root-leaves are numerous, petiolate, very large, oblong, notched, and waved; its stem-leaves are sessile, much smaller, lanceolate, and sometimes toothed or cut; its flowers are numerous, and grow in terminal clusters, and have a white colour, and bloom in May and June; and its silicles are elliptical and bilocular, and contain four seeds in each cell.

The root of horse-radish has a pungent odour, and a very hot, biting, acrimonious yet somewhat sweetish taste. When dried, it loses upwards of two-thirds of its weight; and when kept for a considerable time, it loses all its pungency. It has long been a very favourite garnish to roast-beef; and it certainly is an excellent condiment to any kind of animal food, and eminently possesses some of the properties which prevent or correct the bad effects of an excess of nitrogenous aliment upon the human system. It is medicinally used in some cutaneous diseases, in hoarseness, in dropsy, in chronic rheumatism, and in paralytic affections; and in some cases, particularly the rheumatic and the paralytic, it is both internally taken as a stimulant and externally used as a rubefacient. A dose of it for internal action may be half a drachm or upwards, and may be swallowed either in a finely scraped state or in whole little pieces. Both water and alcohol extract its active principles; and an oil of very pungent odour, of a strong, sweetish-acrid taste, of such acrimonious power as to inflame the tongue or the lips, of a pale yellow colour, and of such volatility as to dissipate at a temperature of 60°, is obtained by distilling the mashed root with water.

Horse-radish succeeds best in a rich, damp, deep soil; it never has large roots in a poor, or dry, or shallow soil, or in a shady situation, or beneath the drip of trees; and it eminently thrives in the trenched bank of a ditch or alluvial flank of a dam or streamlet or deep drain, amid such porosity of ground as to maintain a constant, regular, considerable moisture. The seeds which it produces in Britain are generally abortive, so that they can never be relied upon for sowing. Sets, obtained by cutting the main-root and the offsets into lengths of two inches, and especially any pieces of the root which have each a root-crown or two or three buds, are the usual means of propagation; and these should be planted in February, March, or October, in rows 18 or 24 inches distant each way, and in trenches at least 12 or 15 inches deep; and they may either be dibbled into freshly-trenched ground, or placed on the bottom of each trench while open, and have the mould of the next trench thrown over them; but the soil should lie as lightly upon them as possible, and ought to be softly deposited, and never allowed to be trampled. A writer in the Horticultural Magazine maintains that bits of the roots an inch in length are as good as sets with crowns, and says: "It is well worth one's while to trench in a row or two, in good rich ground, in the month of November. It will come up in May, and form straight good sticks in a year, which thicken into handsome ones in two. When I want one, I dig down to the set, and cut it off close, and cover it up again; but it is better to dig it up clean and place another set there, for the old set is apt to throw up several shoots, and they come weaker." The only requisite after-culture is to prevent a growth of weeds, to clear away the decayed leaves and give a hoeing and raking in autumn, and to give another hoeing and raking in spring. The roots, if wanted, may be taken up in September or October of the second year; a sufficient supply for use throughout winter should be taken up in November, and stored among sand in a cool place; and when the plants stand longer than two years, any suckers which they may throw out during summer ought to be removed as soon as they appear. See the article Scurvy-Grass.

HORSE-RADISH TREE,—botanically *Moringa.* A small genus of tropical plants, of the brasiletto division of the leguminous order. The winged-seeded species, *Moringa pterygosperma*, called by the older botanists *Hyperanthera Moringa*, is a small evergreen tree of India, particularly of Malabar; and was introduced, nearly 90 years ago, to the hothouses of Britain. Its stem usually rises, in India, to the height of 15 or 20 feet; its flowers are yellow; and its pod is very long and about the thickness of a finger. The pod is one of the most esteemed pot vegetables in India, and is commonly eaten made into curry. Its green root is in high request, both among the general population and with physicians, for the same purposes as the root of the horse-radish plant in Britain; and it greatly resembles that root at once in appearance, in taste, and in natural properties. It is prescribed by the Indian practitioners for dyspepsy, hysteria, epilepsy, and intermittent fever; and is also used as a stimulating rubefacient for palsy and chronic rheumatism. The seeds are ranked by some old Arabian writers among the stimulants and aromatics; and an oil is expressed from the seeds in Bengal, and resists rancidity, and is regarded as an excellent external application for gout and acute rheumatism.

HORSE-RAKE. See Hay-Rake.

HORSE-SHOE. See Shoeing, Bar-Shoe, and Foot.

HORSE-SHOE VETCH,—botanically *Hippocrepis.* A genus of yellow-flowered, ornamental plants of the hedysarum division of the leguminous order. The tufted species, *Hippocrepis comosa*, grows wild on the chalk hills of England. Its root is perennial and woody, and runs deep into the ground; its stems are trailing, procumbent, branched at the bottom, and from 6 to 12 inches long; its leaves are narrow, winged, and evergreen; its flowers grow in clusters on the top of long footstalks, and have a deep yellow colour, and rise high above the rest of the plant, and bloom from April till August; and its pods have a bright bay colour, and are upwards of an inch long, and are curved downward, and give rise, by their peculiar form and appearance, to both the popular and the botanical name of the genus.—The single-podded species, *Hippocrepis unisiliquosa*, is a native of the south of Europe, and was introduced to Britain in the latter part of the 17th century. Its root is annual; its stems trail onward for about a foot, and then divide upward into branches; its leaves are pinnate, and have each 4 or 5 pairs of small, obtuse leaflets, and a terminating odd one; its flowers come out singly from the wings of the stems, and have a yellow colour, and bloom in June and July; and its pods sit close to the stems, and are about two inches long and the third of an inch broad, and bend inward like a sickle, and are divided into many joints, shaped like a horseshoe.—Four other hardy annual species, the many-podded, the two-flowered, the ciliated, and the single-fruited,—two hardy perennial-rooted, evergreen, trailing species, the Swiss and the glaucous, — and one somewhat tender, evergreen, undershrubby species, the Balearic,—have been introduced to Britain; and all these, as well as the tufted and the single-podded, have a very handsome appearance, and are well worthy of a place in the flower-garden. The trailing kinds thrive in any sort of light sandy soil, and are very suitable for banks or rockwork.

HORSETAIL. See EQUISETUM.

HORSE-THISTLE. The indigenous species of the genus Cirsium. See the articles CIRSIUM and THISTLE (PLUME).

HORTICULTURE,—from *hortus*, garden, and *colo*, I till,—includes, in its most extensive signification, the cultivation of esculent vegetables, fruits, and ornamental plants, and the formation and management of rural scenery for the purposes of utility and embellishment.

The earliest efforts of savage tribes to emerge from barbarism is directed to the tillage of the earth: the first seed which they plant is the first act of civilization, and gardening is the first step in the career of refinement; but still it is an art in which man last reaches perfection. When the savage exchanges the wild and wandering life of a warrior and hunter, for the confined and peaceful pursuits of a planter, the harvests, herds and flocks take the place of the simple garden. The mechanic arts are next developed; then commerce commences, and manufactures soon succeed. As wealth increases, ambition manifests itself in the splendour of apparel, of mansions, equipages and entertainments. Science, literature and the fine arts are unfolded, and a high degree of civilization is attained. It is not until all this has taken place, that horticulture is cultivated as one of the ornamental arts. Egypt, the cradle of civilization, so far perfected her tillage, that the banks of the Nile were adorned by a succession of luxuriant plantations, from the cataract of Syene to the shores of the Delta; but it was when Thebes, with its hundred brazen gates, and the cities of Memphis and Heliopolis, were rising in magnificence, and her stupendous pyramids, obelisks and temples, became the wonders of the world. The hills and plains of Palestine were celebrated for beautiful gardens; but it was not until the walls and temple of Jerusalem announced the power and intelligence of the Israelites, and the prophets had rebuked their luxury and extravagance. The queen of the East "had heard of the fame of Solomon;" his fleets had brought him the gold of Ophir, and the treasures of Asia and Africa; the kings of Tyre and Arabia were his tributaries, and princes his merchants, when he "made orchards," "delighted to dwell in gardens," and planted the "vineyard of Baalhaman." The Assyrians had peopled the borders of the Tigris and Euphrates, from the Persian gulf to the mountainous regions of Ararat, and their monarchs had founded Nineveh and Babylon before we hear of the gardens of Semiramis. The Persian empire had extended from the Indus to the Archipelago, when the paradise of Sardis excited the astonishment of a Spartan general, and Cyrus mustered the Grecian auxiliaries in the spacious garden of Celænæ. The Greeks had repulsed the invasions of Darius and Xerxes, and Athens had reached the height of her glory, when Cimon established the Academus, and presented it to his fellow-citizens as a public garden. Numerous others were soon planted, and decorated with temples, porticoes, altars, statues and triumphal monuments; but this was during the polished age of Pericles, when Socrates and Plato taught philosophy in the sacred groves; when the theatre was thronged to listen to the poetry of Euripides and Aristophanes; when the genius of Phidias was displayed in rearing the Parthenon and sculpturing the statues of the gods; when eloquence and painting had reached perfection, and history was illustrated by Herodotus, Thucydides and Xenophon. Rome had subjugated the world, and emulated Athens in literature, science and the arts, when the superb villas of Sallust, Crassus, Pompey, Cæsar, Mæcenas and Agrippina were erected, and the palaces of the emperors were environed by magnificent gardens. The history of modern nations presents similar results. Horticulture long lingered in the rear of other pursuits. Most of the common fruits, flowers and oleraceous vegetables which had been collected by the Greeks and Romans, from Egypt, Asia, and other distant climes, were successively extended over Western Europe; but so gradual was their progress, after the dark ages, that, till the reign of Henry VIII., scarcely any kitchen vegetables were cultivated in England, and the small quantity consumed was imported from Holland. Fuller observes, that "gardening was first brought into England, for profit, about the commencement of the 17th century. Peaches, nectarines, apricots, plums, pears, cherries, strawberries, melons and grapes, were luxuries but little enjoyed before the time of Charles II., who introduced French gardening at Hampton-court, Carlton and Marlborough, and built the first hot and ice houses. At this period Evelyn translated the 'Complete Gardener,'" and a treatise on orange-trees, by Quintinyne; and, having devoted the remainder of his life to the cultivation of his rural seat at Sayes-court, near Deptford, and the publication of his 'Sylva,' 'Terra,' 'Pomona,' and 'Acetaria,' he "first taught gardening to speak proper English." In the Netherlands, France, Germany and Italy, a formal and very imperfect system of gardening was practised, with considerable success; but it was generally in a languishing condition, throughout the world, until the commencement of the 18th century, when it attracted the attention of some of the first characters of Great Britain; but the establishment of the present improved style of horticulture is of very recent date. "Bacon was the prophet, Milton the herald, and Addison, Pope and Kent the champions of true taste." The principles which were developed in their writings, and those of Shenstone, the Masons and Wheatly, were successfully applied by Bridgeman, Wright, Brown and Eames; the system soon became popular, and gradually extended over Europe, and ultimately reached the United States. But the labours of the London Horticultural Society have mainly contributed to the perfection and present high estimation of gardening. That noble institution has given an impetus to cultivation, which is felt in the remotest countries. Its example has been followed in the most flourishing kingdoms of the eastern continent, and many similar institutions have been founded in the United States. The effect of these is to diffuse through every country the knowledge and products of all.

The history, literature and science of gardening, open a wide field for study and inquiry. The pleasure which gardens afforded men, even in the earliest times, appears from the scriptural account of the garden of Eden. The garden of Gethsemane, and that of the good and just Arimathean, are memorable in the sacred history of the Messiah. The Elysian fields were the heaven of classic mythology, and the devout Mussulman hopes to renew his existence in a celestial paradise. The bards, scholars and philosophers of the classic ages, have transmitted descriptions of the gardens of the ancients, from those in which Homer places the palace of Alcinous and the cottage of Laertes, to the splendid villas of Pliny and Lucullus. Among the ancient Greek writers, Hesiod, Theophrastus, Xenophon, and Ælian treated of gardens to a certain extent; and the works of those who wrote after the seat of government was removed to Constantinople, were collected under the title of *Geoponica*, and have been translated by Owen. Among the Latins, Varro was the first author, to whom succeeded Cato, Pliny the Elder, Columella and Palladius. Passages are to be found, relative to the subject, in Martial, Virgil, and Horace; but Pliny's Natural History, and Columella's book on gardens, contain the most correct information on Roman horticulture. Literature and the arts having revived in Italy, that country was the first to produce books on agriculture and gardening, and that of Crescenzia became celebrated. The field and garden cultures of Italy are so nearly allied, and horticulture and agriculture have been so blended by the writers, that it is difficult to ascertain under which department to include their works. The best for general information on the tillage of that delightful region is the 'Annali dell' Agricultura.' The Germans, as in all the branches of letters, science and arts, have an immense number of books in the department of gardening, especially on the subject of planting and forest trees Those which furnish the best idea of the state of culture in that country, are Deitrich's 'Worterbuch,' with the supplement of 1820, and Sickler's 'Deutsche Handwirtschaft.' The Dutch excel more in the practice than the literature of gardening. They have no work of very recent date: that of Commelin, which was published about the middle of the 17th century, is among the earliest; and those of La Court and Van Osten are said to be among the best that have appeared. The Journal of a Horticultural Tour in Holland and Flanders by a deputation of the Caledonian horticultural society, gives the most satisfactory account of gardening in that part of the continent, in 1817. The Transactions of the Stockholm and Upsal Academies furnish the chief information which is to be obtained, in relation to the rural economy of Sweden. The first author was Rudbeck, who was a contemporary of Commelin. Russia and Poland have produced but very few original books on horticulture. The Agricultural Transactions occasionally published by a society in Warsaw, with those of the Economical Society of St. Petersburg, may be considered as affording the most accurate intelligence as to the culture of those countries. In the latter city is an extensive imperial botanical garden, which, being under the direction of able professors, emulates those of the more favoured portions of southern Europe. The only recorded source for obtaining any knowledge of Spanish tillage, are the Transactions of the Royal Agricultural Society of Madrid. The horticultural literature of France is of an early date, and the authors are not only numerous, but many of them in the highest repute. Etienne and Belon were the pioneers, while Du Hamel, Girardin, D'Argenville, Rosier, Tessier, Calvel, Noisette, Du Petit Thours, Jean and Gabriel Thouin, Bosc and Vicomte Hericart de Thury, may be considered as among the most able of their followers, in the various branches of rural economy. For a general knowledge of French culture, the 'Nouveau Cours d'Agriculture,' in 13 volumes, published in 1810, should be consulted; but the most valuable publications on the existing mode of gardening, are the monthly 'Annales de la Société d'Horticulture,' the 'Annales de l'Institut Royal Horticole de Framont,' and the 'Bon Jardinier' an annual publication, compiled by Professors Poiteau and Vilmorin.—The first English treatise on rural economy was Fitzherbert's Book of Husbandry, which was published in 1634. The works of Tusser, Googe and Platt soon after appeared, and early in the 18th century, the celebrated treatise of Jethro Tull excited much attention; and several new works of considerable merit were announced before 1764, when the valuable publications of Arthur Young, Marshall, and numerous other authors, spread a knowledge of cultivation, and cherished a taste for rural improvements, throughout Britain, and the subsequent literature of horticulture rapidly advanced. The citizens of the United States have been chiefly dependent on England for books relating to agriculture and gardening. Still several have appeared by native writers, which are highly creditable to the authors and the country; especially those which relate to the botanical department. Mulenburg, Bigelow, Eliot, Torry, Colden, Bartram, Barton, Hosack, Mitchel, Darlington, Ives, Dewey, and Hitchcock, are entitled to great praise for their successful attempts to illustrate the American flora. One of the earliest American writers on husbandry was Belgrove, who published a treatise on husbandry, in Boston, in 1755; and in 1790, Deane's New England Farmer appeared; but M'Mahon, Cox, Thacher, Adlam, Prince, Bundly, Butler, Nicholson and Fessenden, since the commencement of the present century, have produced works on the various cultures of the United States, which are generally circulated, and held in great estimation.

The scientific relations of horticulture are numerous, and require an extensive acquaintance with the various branches of natural history and physics. Botany, mineralogy, chemistry, hydraulics, architecture, and mechanics must furnish their several contributions, which it is the province of the artist to apply. After the illustrious Linnæus published his 'System of Nature,' botany became a popular science, and a variety of interesting elementary works awakened attention to the beauties of nature, and a passion for experimental and ornamental planting was induced, which has been productive of great results. Mineralogy enables us to obtain accurate knowledge of terrestrial substances, and the mode of distinguishing the divers kinds of earths which constitute a cultivable soil; and chemistry instructs us as to the nature and properties of these various earths, having for its objects, when applied to horticulture, all those changes in the arrangements of matter, which are connected with the growth and nourishment of plants, the comparative value of their produce as food, the constitution of soils, the manner in which lands are enriched by manure, or rendered fertile by the different processes of cultivation. Inquiries of such a nature cannot but be interesting and important, both to the theoretical horticulturist and the practical gardener. To the first they are necessary in applying most of the fundamental principles on which the theory of the art depends. To the second they are useful in affording simple and easy experiments for directing his labours, and for enabling him to pursue a certain and systematic plan of improvement. To hydraulics belong, not only the conducting and raising of water, with the construction of pumps and other engines for those purposes, but the laws which explain the nature of springs and fountains. By the principles of that science, artificial lakes, canals and aqueducts are formed, irrigations projected, and water rendered subservient to the useful purposes of life, as well as to the embellishments of pleasure-grounds by *jets d'eau*, cascades and streams. Architecture, as a branch of horticulture, is of the first importance. Without its aid, it would be impossible to give that propriety and elegance to the scenery, and to produce that pleasing effect, which is the chief object of landscape gardening. Mechanics, in all its branches, is required for the purposes of horticulture.

Great improvements have been effected in gardening within the last half century. During the age of Cicero, a formal kind of gardening prevailed, characterized by clipped hedges and long avenues of trees. Pliny the Younger has given an account of his villa at Laurentum, and from the description, it was rather distinguished for its numerous superb edifices, extensive prospects, and the systematical arrangement of the pleasure grounds, than for the improvements and decorations of the surrounding scenery, in accordance with those principles which are derived from a close observance of the pleasing effects of nature. The rural residences of the Romans appear to have been mere places of temporary retreat, and were planted with odoriferous flowers and shrubs, and ornamented rather by the civil architect than the horticultural artist. From the establishment of the papal government to the commencement of the 13th century, the monks were the only class of persons who attended to ornamental gardening. After that period, the style prevalent throughout Europe consisted in tall hedges, square parterres, fantastically planted, straight walks, and rows of trees uniformly placed and pruned. In fact, but little improvement was made from the time of the emperors Vespasian and Titus until the reign of George III. of England. It is true, Hampton-court had been laid out by Cardinal Wolsey; Le Notre had planted Greenwich and St. James's Park during the reign of Charles II.; and, in that of George II., Queen Caroline had enlarged Kensington gardens, and formed the Serpentine river; but Lord Bathurst was the first who deviated from straight lines, as applied to ornamental pieces of water, by following the natural courses of a valley. Still, what has been emphatically called the *Dutch system* universally prevailed, and the shearing of yew, box and holly into formal figures of various kinds, and the shaving of river banks into regular slopes, went on until their absurdity became contemptible, and a better and more natural taste was induced. Verdant sculpture, regular precision in the distribution of compartments, and rectangular boundary walls, yielded to more chaste designs. Bridgeman succeeded to Loudon and Wise, and became a distinguished artist; he rejected many of the absurd notions of his predecessors, and enlarged the bounds of horticulture. Other innovators departed from the rigid rules of symmetry; but it was reserved for Kent to realize the beautiful descriptions of the poets, and carry the ideas of Milton, Pope, Addison and Mason more extensively into execution. According to Walpole, he was painter enough to taste the charms of landscape, sufficiently bold and opinionative to dare and to dictate, and born with a genius to strike out a great system from the twilight of imperfect essays. He leaped the fence and saw that all nature was a garden. The great principles on which he worked were perspective, light and shade. Groups of trees broke a too extensive lawn; evergreens and wood were opposed to the glare of the champaign, and, by selecting favourite objects, and veiling deformities, he realized the compositions of the great masters in painting. Where objects were wanting to animate his horizon, his taste as an architect could immediately produce them. His buildings, his temples, his seats were more the work of his pencil than of his science as a constructor. He bade adieu to all the stiff modes of canals, circular basins, and cascades tumbling over marble steps. Dealing in none but the true colours of nature, and seizing upon its most interesting features, a new creation was gradually presented. The living landscape was chastened or polished, not transformed. The elegant works of Repton, the unrivalled essays of Price on the picturesque, and the valuable publications of Gilpin, Madock, Panty, Sang and Loudon, with those of many other writers, on landscape and ornamental gardening, have had an extensive influence in promoting correct ideas of natural scenery. The improved style of horticulture, every where apparent in Great Britain, attracted the attention of the other nations of Europe, and English gardening became the designation for all that was beautiful in that pleasing art—the synonyme of perfection in rural culture.

At the period when this new system of laying out grounds was gaining converts, and began to be practically adopted, Viscount Girardin, a French military officer of high rank, travelled through England, and, on his return, he not only improved his seat at Ermenonville in conformity to that style, but published a work of great celebrity on the 'Composition des Paysages sur le Terrain, ou des Moyens d'embellir la Nature près des Habitations.' The French style of laying out gardens had been settled by Le Notre, during the reign of Louis XIV., and continued in repute for upwards of a century; for it appears to have been in vogue as late as 1770. The court and nation wished to be dazzled by novelty and singularity, and his long, clipped alleys, triumphal arches, richly decorated parterres, his fountains and cascades, with their grotesque and strange ornaments, his groves full of architecture and gilt trellises, and his profusion of statues, enchanted every class of observers. His principal works were the gardens of Versailles, Meudon, St. Cloud, Sceaux, Chantilly, and the terrace of St. Germain. Gray, the poet, was struck with their splendour when filled with company, and when the water-works were in full action; but Lord Kaimes says, they would tempt one to believe, that nature was below the notice of a great monarch. Le Notre was succeeded by Dufresny, who, differing considerably in taste from that great artist, determined on inventing a more picturesque style; but his efforts were rarely carried into full execution. He, however, constructed, in a manner superior to his predecessor, the gardens of Abbé Pajot and those of Moulin and Chemin creux. After the peace of 1762, the English system began to pass into France, and portions of ancient gardens were destroyed to make way for young plantations *à l'Anglaise*. Laugier was the first author who espoused the English style, and the next in order was Prevot. It was at this time that Viscount Girardin commenced his improvements at Ermenonville, and the change of the horticultural taste in France may be referred to the last quarter of the 18th century. The English style has gradually found its way into most civilized countries. Within 25 years of the establishment of the London Horticultural Society upwards of 50 similar institutions were established in Great Britain; and this country still maintains the first rank in the art; but France is making great efforts to rival her. A horticultural society was established in Paris in 1826, and soon had upwards of two thousand members. It has been patronised by the court, and most of the nobles and men of distinction in France have eagerly united with the proprietors of estates and practical cultivators to collect and disseminate intelligence throughout that flourishing empire. In the various provinces where horticultural societies have not been founded, those of agriculture, or of the sciences and arts, have established departments expressly devoted to that interesting pursuit; and during the year 1827 a practical and theoretical institution was founded at Fromont, by the enlightened and munificent chevalier Soulange Bodin, for educating gardeners and introducing improvements in every department of horticulture. The garden contains about 130 acres, and is divided into compartments for every variety of culture. Extensive green-houses, stoves and orangeries have been erected, and all the other appendages furnished, which are requisite for rendering the establishment effectual for instruction and experiment. The nursery of the Luxembourg long supplied a great part of Europe with fruit trees. The *jardin des plantes*, in Paris, includes compartments which may be considered as schools for horticulture, planting, agriculture, medical botany and general economy, and is unquestionably the most scientific and best managed establishment in Europe. The flower garden of Malmaison, the botanical garden of Trianon, and numerous nursery, herb, medicinal, experimental and botanical gardens, in various parts of the kingdom, are pre-eminent for the variety, number and excellence of their products.

Holland has been distinguished, since the period of the crusades, for her flower gardens, culinary vegetables, and plantations of fruit trees. The north of Europe and the United States are still dependent upon her florists for the most splendid varieties of bulbous rooted plants. From St. Petersburg to the shores of the Mediterranean, horticulture has made a rapid progress, and each nation is emulous to perfect its culture, in accordance with the most improved principles of science, art and taste. In the United States, a like spirit has been more recently developed. Horticultural societies have been instituted in New York, Philadelphia, Boston, Albany, Geneva and South Carolina, and a zealous disposition evinced to compete with the nations of the eastern continent.

The natural divisions of horticulture are the esculent or kitchen garden, seminary, nursery, fruit trees, and vines, flower garden, green-houses, *arboretum* of ornamental trees and shrubs, the botanical and medical garden, and landscape or picturesque gardening. Each of these departments requires to be separately studied before it can be managed so as to combine utility and comfort with ornament and recreation. To accomplish this on a large scale, artists, scientific professors, and intelligent and experienced practical superintendents, are employed. The kitchen garden is an indispensable appendage to every rural establishment. In its simplest form, it is the nucleus of all others. Containing small compartments for the culture of esculent vegetables, fruits and ornamental plants, these may be gradually extended, until the whole estate assumes the imposing aspect of picturesque or landscape scenery. The details of the several grand divisions of horticulture are to be learned from the numerous authors who have devoted their especial attention to each; and some of the chief should be consulted by every gentleman who wishes to participate in the comforts and luxuries of a garden. It is only necessary that information should be disseminated, and examples presented by the more intelligent and opulent, to remove the too common prejudice, that gardens are costly and useless appendages, requiring great expenditure and labour, without any adequate profit or satisfaction. So far from this, there is not a farmer, not an owner of an acre of land, who will not be enriched or gratified by devoting a portion of his industry to the tillage of a garden: they may find many hours which can be thus profitably and pleasantly employed. Personal attention, with judicious arrangements, and a proper division of labour, will accomplish much. Many of the most valuable products of agriculture were first introduced, and their qualities tested, in the garden. "If, therefore," says the learned and eloquent Poiteau, "we would ascend to the origin of agriculture, it is in the garden that her cradle will be found. There, like the young Hercules, she first tried her powers, and prepared, like him, to overrun the world, which she speedily cleared of monsters, and bestowed upon man the laws of civilization." In all ages and countries, flowers have been universally cherished. "Who," asks Boursault, "does not love flowers? They embellish our gardens; they give a more brilliant lustre to our festivals; they are the interpreters of our affections; they are the testimonials of our gratitude; we present them to those to whom we are under obligations; they are often necessary to the pomp of our religious ceremonies, and they seem to associate and mingle their perfumes, with the purity of our prayers, and the homage which we address to the Almighty. Happy are those who love and cultivate them." The ancients paid particular attention to flowers. They were in great request at the entertainments of the wealthy; they were scattered before the triumphal chariots of conquerors; they formed the distinguishing insignia of many divinities; they glitter as gems in the diadem of the seasons, and constitute the mystical language of poetry. We are told that Descartes prosecuted, with equal ardour, astronomy and the culture of flowers. The great Condé devoted his leisure hours to that delightful pursuit, and the vase of flowers was daily renewed upon the table of Lord Bacon, while composing the volumes of his sublime philosophy. In the cities of Europe, flower-markets, for the sale of bouquets and ornamental plants, are as common as those for fruits. Among the European productions on horticulture, there is no single work in the English language so valuable as Loudon's 'Encyclopædia of Gardening;' but all the numerous publications of that distinguished writer, in the various branches of rural economy, are remarkable for the fund of intelligence which they contain.

HORTUS SICCUS. See Herbarium.

HOSACKIA. A genus of ornamental plants, of the lotus division of the leguminous order. The two-coloured species, *H. bicolor*, was introduced to Britain from North America in 1826; and is a perennial-rooted, evergreen creeper, of much beauty, with yellow-and-white flowers, and blooming from July till September. Several subsequently introduced species have different habits from the preceding, and are assigned by some botanists to the genus Lotus. The creeping-rooted species, *H. stolonifera*, was introduced from California in 1830, and is an interesting and curious hardy evergreen herb, with much of the appearance of a shrub. Its stems are smooth, and about 3 feet high; its leaves are pinnate, and have each about 7 pairs of ovate, mucronulate leaflets, and a terminating odd one; and its flowers grow in capitate umbels, and have a chocolate-reddish colour, and bloom in June, but have not an attractive appearance. This plant looks like a stout shrub, and readily multiplies itself by its stoloniferous roots, and serves admirably for a place in a shrubbery where a rapid formation of the appearance of undergrowth is desired.

HOSTA. A small genus of Mexican, ornamental, blue-flowered, evergreen shrubs, of the verbena order. The blue species, *Hosta cærulea*, called by some botanists *Cornutia punctata*, was introduced about the same time as the *Cornutia pyramidata*, and is very nearly allied to that plant. See the article Cornutia. Two other species, the long-leaved and the broad-leaved, were introduced about 22 years ago; and, as well as the preceding, have naturally a height of about 6 or 8 feet.

HOTBED. A prepared, compact mass of fermenting vegetable matter, in such a state as steadily and prolongedly to evolve a moderate degree of heat, and usually covered with a glazed frame, and employed for the striking of such cuttings and the cultivation of such plants as agree well with bottom-heat and require more warmth and moisture than can be enjoyed in the open ground. Hotbeds were formerly in much more extensive use than at present; and they have been found far less adapted than some modern contrivances for many of the purposes of the old bottom-heat cultivation; yet they are still valuable for growing melons and cucumbers, for raising tender annuals and other tender plants from seeds, and for the safe and rapid propagation of many kind of plants from cuttings. See the articles Bottom-Heat, Bark-Bed, and Cucumber.

A mere forcing-bed, or such a moderately fermenting mass as accelerates the yearly growth of reluctant or slightly tender culinary plants, requires no superimposed frame, and may be formed for most plants on the same principle as for asparagus. See the article Asparagus. A real hotbed, or such a fermenting mass as will yield sufficient heat and moisture for the ordinary growth of tender plants, always requires a frame, yet admits of great variety of construction, and may consist of fresh stable-dung and intermixed litter, of tanner's bark, of tree leaves, or of any other fermentable substances and composts which possess the property of decomposing with such velocity and in such a manner as to give out the requisite degree and steadiness of heat. See the article FRAME. But the most commonly used material is fresh stable-dung with a due intermixture of litter; and this is prepared for the bed, by being thrown into a heap,—by receiving as much moisture as may be requisite to bring the dry portions of its litter into fermentation,—and by being two or three times turned over, and having its parts thoroughly intermixed, during the process of fermentation. Miller says, "The dung should be thrown up in a heap, mixing therewith a few sea-coal ashes, which will be of service to continue the heat of the dung; it should remain 6 or 7 days in this heap; then it should be turned over, and the parts well mixed together, and cast into a heap again; where it may continue 5 or 6 days longer, by which time it will have acquired a due heat."

A hotbed ought to be formed in a dry situation, and placed open to the south, and well sheltered from easterly, northerly, and even westerly winds; and it will do all the better if it have walls and trees, or at least very compact and lofty hedges, on the east and the north. Its outline ought, on every side, to be 5 inches or so beyond that of the dimensions of the frame intended for it; and its floor ought, for the sake of admitting heat from what is technically called "a lining," to consist of a layer of faggots or of brushwood. Its sides and its ends ought to be quite vertical; its mass or substance ought wholly to consist of successive and compactly-beaten layers of the prepared material; and its height, when a strong bottom-heat is required, may be from 3½ to 4½ feet in front and from 4½ to 5½ feet in rear. Or when only a very gentle bottom-heat is wanted, the bed must be lower and may be more compactly beaten or compressed by treading. As soon as the bed is formed, the frame is put on; as soon as the excessive heat has moderated, a layer of mould for the cultivation of plants, or of sand, rotten-tan or leaf-mould for the plunging of pots with seeds or cuttings, is spread on the top of the bed; and as soon as the layer acquires a proper temperature, the plants are introduced. When the heat begins to diminish, "a lining" must be applied, and this may consist simply of leaves, newly-cut short grass, fresh stable dung, or a mixture of these substances, loosely deposited against the sides of the bed. When a hotbed happens to be so made as to evolve too much heat, the only effectual remedy is to remove the plants from it, and to re-make it, with the intermixation of some materials of less violent and more tardy fermentability.

In winter, the heat of hotbeds, as they are usually made, cannot without great difficulty be so evolved as sufficiently to repel frost, and is liable either to be overpowered by the frost, or to burn the soil under the roots of the plants. Mr. Knight, the late president of the Horticultural Society, and well-known phytologist, recommended, as a means of getting full command of the interior heat, to place a thin iron or wooden tube from the front to the back of the leaves or dung composing the bed, at about one-third of the bed's height from the top,—the tube to be about 1½ inch in diameter, and open at both ends, but intended to be plugged up or kept open at pleasure,—and three smaller tubes, each three-fourths of an inch in diameter, inserted at equal distances into the large one, and to rise through the dung and mould of the bed, and discharge by lateral holes near their top the heated air which ascends from the large tube. This simple apparatus Mr. Knight asserted to be sufficient to keep the air within a frame of 6 feet in length at a proper temperature; and if the glass of the frame be laid in lead or have its lappings puttied up, he asserted this apparatus to be able also to resist any degree of cold without the aid of mat-coverings, and so to permit the plants on the bed to enjoy full light along with the heat.

A facile and economical substitute for a hotbed for forcing cucumbers was reported on, as follows, by C. S. Dickens, Esq., to the Horticultural Society:—"Instead of forming a solid bed of dung, as is usually done, he constructs four brick piers, 18 inches high and 9 inches square, to support a two-light frame. Two pieces of timber, 4 inches square, are laid from pier to pier at back and front; on these are laid a platform of boards 1½ inch thick; these are planted with neats' dung, which when dry is covered two inches thick with good mould, and the frame is placed on the piers. Under the centre of each light a bushel of mould is laid, forming a hillock. After this, the lights are put on, and linings of hot dung applied all round, the interior space remaining hollow. In two days the bed is fit for use. If the heat is found to decrease, a wheel-barrow-full of fresh dung is added, and shaken up with the linings, and well watered. In order to confine the heat, the whole of the linings are plastered with neats' dung, by which means a temperature is obtained of from 75 to 80 degrees."

HOTHOUSE. A glazed structure suitable for the cultivation of the most tender kinds of exotic plants. Some writers understand hothouses to mean all glazed horticultural structures whatever; but most exclude from the word all frames, orangeries, camellia-houses, conservatories, and green-houses, and restrict it to walled and glazed buildings for the cultivation of plants requiring a minimum heat of 50° by night and 55° by day in the middle of winter. Hothouses, understood in this latter and more convenient sense, comprise the four classes of forcing-house, bark-stove, dry stove, and damp stove, and include in the last of these classes the palm-house, the banana-house, the orchis-house, and some other subdivisions; and are, in every instance, so constructed and furnished and applianced as to afford to the particular collections of plants cultivated in them an artificial atmosphere as nearly as possible resembling that of their natural climate.

Four conditions are essential in every hothouse,—the free access of the utmost possible amount of light, the regulated admission of the fresh air, the constant command of the requisite degree of heat, and the regulated diffusion of the proper degree of moisture. Any form which secures these conditions is practically suitable, no matter how offensively ugly or how elaborately elegant; but the simplest form which can comport with perfect freedom from meanness or bad taste, is best in keeping both with the uses of the structure, and with the general style of even the most elegant garden.

The site of a hothouse ought to be as dry as possible; and if not naturally dry, must be thoroughly under-drained. Dampness of ground beneath a hothouse sends up vapours at night when the house is shut, and occasions tender plants to damp off, and some ripening fruits to have a sickly colour and a bad flavour. The aspect of every hothouse ought to be southerly, both for the sake of securing the utmost power and quantity of light, and for the sake of obtaining as high a degree as possible of natural heat. Bricks are the best materials for the walls; and, though stones should be used for the body of them, bricks ought to be built up for an interior facing; for walls built entirely of stone are, in few instances, sufficiently impermeable by exterior moisture. The best Memel timber, or some other wood of kindred properties, ought to be used for the timber-work; for if wood of any inferior quality be employed, it will warp under the combined action of powerful heat and excessive wet. The slope or inclination of the roof may be at any angle between 32° and 45°; the rafters may be 10 inches deep and 2½ inches broad, or a little shallower and broader; the sashes may be from 3½ to 4 feet broad, and must have a length proportioned to the size of the house; and all the frame-work ought to be well coated with oil paint. Some roofs are made without rafters or moveable sashes; but though these admit a maximum of light, they involve the enormous disadvantage of not affording any facility, or even any means whatever, for regulating the admission of fresh air. Rafters of either cast iron or malleable iron are preferred by some persons to wooden rafters; but, though they present less obstruction to the play of light, and look more chaste and ornamental, they cost nearly three times more money, and are probably not so durable, and occasion injury to some plants from the excessive heat of their conduction during summer and the excessive cold of their radiation during winter, and operate so mischievously by their expansion with heat and contraction with cold as sometimes to fracture the glass, to render the sashes immoveable, and to loosen the walls. Rafters are sometimes constructed of medium character between wooden and metallic; or with the mortices of wood and the tenons of metal; but, just in the proportion in which they are metallic, they occasion the same evils as rafters composed entirely of iron.

"In order to secure the greatest possible influx of light," says Dr. Neill, in his Fruit, Flower, and Kitchen Garden; "scientific horticulturists have proposed hothouses with curvilinear roofs. It was remarked by Sir George S. Mackenzie, to whom the merit of the proposal is primarily due, that, if we could find a form for a glass-roof, such that the sun's rays should be perpendicular to some part of it, not on two days, but during the whole year, that form would be the best. Such a figure is the sphere; and he therefore proposes a quarter-segment of a globe, or semi-dome, the radius of which is about 15 feet. The frame for the glass-work is formed of equal ribs of hammered iron, fastened into an iron plate in the parapet wall, and fixed at top into an iron ring connected with the back wall. There are no rafters or sliding-sashes; but air is admitted by ventilators on the parapet and back walls. This form of hothouse roofs was warmly patronised by the late Mr. Knight, who, however, was of opinion that the house proposed by Sir George Mackenzie was too high in proportion to its length and breadth, and therefore recommended a smaller section of a sphere with a greater radius. His dimensions are 40 feet long, 14 feet wide in the centre, and, including the front parapet, 12 feet high. Mr. Loudon, who, it is understood, was the first that actually erected hothouses on this principle, has proposed, and in part executed, many subvarieties of form. He describes, with great exuberance of invention, the acuminated semidome, the acuminated semi-globe, the semi-ellipse, and the parallelogram with curved roof and ends. With Mr. Loudon we should certainly prefer the last-mentioned." But though curvilinear roofs have now been somewhat extensively tried, and have found much favour for flowering-plant hothouses in some large gardens, and seem to be as suitable as they are elegant for large and miscellaneous collections of ornamental plants, they serve ill for banana-houses, vineries, and some other specific structures, and occasion concentrations of light and heat from the sun's rays which seriously injure succulency and fructification, and will, in all probability, never be preferred to the common sloping roofs either for small hothouses or by almost any practical gardeners.

It has been found that plants growing in stove houses often suffer from the scorching influence of the solar rays, and great expense is frequently incurred in fixing blinds to cut off this destructive caloric influence. From the enormous size of the new palm-house at Kew, it would be almost impracticable to adopt any system of shades which would be effective—this building being 363 feet in length, 100 feet wide, and 63 feet high. It was therefore thought desirable to ascertain if it would be possible to cut off these scorching rays by the use of a tinted glass, which should not be objectionable in its appearance, and the question was, at the recommendation of Sir William Hooker and Dr. Lindley, submitted by the commissioners of woods, &c., to Mr. Hunt. The object was, to select a glass which should not permit those heat rays which are the most active in scorching the leaves of plants to permeate it. By a series of experiments made with the coloured juices of the palms themselves, it was ascertained that the rays which destroyed their colour belonged to a class situated at that end of the prismatic spectrum which exhibited the utmost calorific power, and just beyond the limits of the visible red ray. A great number of specimens of glass variously manufactured were submitted to examination, and it was at length ascertained that glass tinted green appeared likely to effect the object desired most readily. Some of the green glasses which were examined obstructed nearly all the heat rays; but this was not desired—and from their dark colour these were objectionable, as stopping the passage of a considerable quantity of light, which was essential to the healthful growth of the plants. Many specimens were manufactured purposely for the experiments by Messrs. Chance of Birmingham, according to given directions, and it is mainly due to the interest taken by these gentlemen that the desideratum has been arrived at. Every sample of glass was submitted to three distinct sets of experiments:—1st, To ascertain, by measuring off the coloured rays of the spectrum, its transparency to luminous influence. 2d, To ascertain the amount of obstruction offered to the passage of the chemical rays. 3d, To measure the amount of heat radiation which permeated each specimen. The chemical changes were tried upon chloride of silver, and on paper stained with the green colouring matter of the leaves of the palms themselves. The calorific influence was ascertained by a method employed by Sir John Herschel in his experiments on solar radiation. Tissue paper stretched on a frame was smoked on one side by holding it over a smoky flame, and then, when the spectrum was thrown upon it, the other surface was washed with strong sulphuric ether. By the evaporation of the ether the points of calorific action were most easily obtained, as these dried off in well-defined circles long before the other parts presented any appearance of dryness. By these means it was not difficult, with care, to ascertain exactly the conditions of the glass, as to its transparency to light, heat, and chemical agency (actinism). The glass thus chosen is of a very pale yellow green colour, the colour being given by the oxide of copper, and is so transparent that scarcely any light is intercepted. In examining the spectral rays through it, it is found that the yellow is slightly diminished in intensity, and that the extent of the red ray is affected in a small degree, the lower edge of the ordinary red ray being cut off by it. It does not appear to act in any way upon the chemical principle, as spectral impressions obtained upon chloride of silver are the same in extent and character as those procured by the action of the rays which have passed ordinary white glass. This glass has, however, a very remarkable action upon the non-luminous heat rays, the least refrangible calorific rays. It prevents the permeation of all that class of heat rays which exist below and in the point fixed by Sir William Herschel, Sir H. Englefield, and Sir J. Herschel, as the point of maximum calorific action. As it is to this class of rays that the scorching influence is due, there is every reason to conclude that the use of this glass will be effective in protecting the plants, and at the same time, as it is unobjectionable in point of colour, and transparent to that degree which is necessary for the development of those parts of the plant which depend upon external chemical excitation, it is only partially so to the heat rays, and it is opaque to those only which are the most injurious. The absence of the oxide of manganese, commonly employed in all sheet glass, is insisted on, it having been found that glass, into the composition of which manganese enters, will, after exposure for some time to intense sunlight, assume a pinky hue, and any tint of this character would completely destroy the peculiar properties for which this glass is chosen. Melloni, in his investigations on radiant heat, discovered that a peculiar green glass, manufactured in Italy, obstructed nearly all the calorific rays; we may therefore conclude that the glass chosen is of a similar character to that employed by the Italian philosopher, the tint of colour is not very different from that of the old crown glass; and many practical men state that they find their plants flourish much better under this kind of glass than under the white sheet glass, which is now so commonly employed.

Fermenting vegetable substances have, in some instances, been employed to produce and maintain the requisite heat in vineries, peach-houses, and what are called bark-stoves, on the same principle and nearly in the same manner as in bark-beds and hot-beds; but they by no means serve so well as the modern and improved method of heating by means of steam and hot water, or even, under good management, as the old method of heating by means of flues. See the articles BOTTOM-HEAT, BARK-BED, and HOT-BED.—Flues raise the temperature, and keep it up, by radiating heat from smoke and air; and they ought to be so far detached from the walls of the building, as to radiate heat only from smoke and air, and not through the medium of bricks and stone and mortar of the walls. They are usually constructed throughout of common brick; but the part of them immediately adjacent to the furnace may very advantageously be constructed of fire-brick; and their covers may consist either of tiles or of sandstone flags. They have been very commonly made about 18 inches deep, and from 15 to 18 inches wide; but they radiate far more heat, and are therefore far more economical, when made nearly twice as wide as they are deep. Moistness of atmosphere in a hothouse heated by flues, may be maintained either by frequently syringing the flues and the passages so as to produce copious evaporation, or by having a closed groove or channel along the upper surface of the flues, and keeping this constantly supplied with water.—Steam, conveyed in pipes, readily and easily maintains the requisite temperature, and does not contaminate the air, and occasions a saving in the cost of fuel, and operates more healthily than flue-heat upon the great majority of plants, and may, by the mere opening of a valve, be made, at any time, to communicate to the atmosphere any required degree of moisture; and, for almost any suite of hothouses, whether small or great, it may be generated in a single oblong boiler, furnished with safety-valves, and heated by a smoke-consuming furnace, and self-regulatingly supplied with water from a cistern situated above it.—Hot water, by being circulated in iron pipes, produces and maintains heat as well as steam, with the additional advantages of not risking the rupture of the pipes, and of evolving the heat more steadily, more durably, and less subject to control from sudden changes in the open atmosphere. One of the earliest and simplest methods of heating by hot water — and a method still eminently suitable for small hothouses—is to place a boiler and a cistern on a common level at the remote end of the house, to pass a pipe from near the top of the boiler to near the top of the cistern, and to pass a return pipe from a lower part of the cistern to a correspondingly low part of the boiler; so that, in consequence of the mere difference of gravity between the hotter water of the one pipe and the colder water of the other, a constant circulation may be maintained. One of the more improved and complicated methods is to produce and maintain the circulation on the principle of the siphon; and another is to use a coil of small pipes hermetically sealed, and to enclose them in a furnace instead of a boiler. Moistness of atmosphere from hot water can be obtained either by constant evaporation from close grooves arranged along the whole length of the pipe, or by the cautious and infiltrated introduction of steam from the boiler.

The ventilation of hothouses is of vast importance, partly for correcting occasional excess of temperature, and chiefly for supplying the plants with the carbonaceous and ammoniacal elements of the external atmosphere. The food of plants has been shown in our articles AGRICULTURAL CHEMISTRY, AIR-PLANTS, AMMONIA, CARBONIC ACID, FOOD OF PLANTS, and many others, to be derived far more from the free atmosphere than from the soil; so that a regular and abundant supply of fresh air to the multitude of plants which are crowded into the small space of a hothouse is as necessary to keep them feeding and growing with its carbon and ammonia, as a similar supply of it to a number of human beings or domestic animals crowded into a room is necessary to keep them breathing with its oxygen. The contrivances for ventilation ought to be powerful enough to prevent all excess of heat, and at the same time gentle and facile enough to admit, at any critical time, the softest and most limited supplies of air; and, while commanding the most ample communication with the external atmosphere, they must, in no instance, permit the influx of such a rush or current of it as would prevent the flame of a common candle from burning steadily in their immediate vicinity. Most gardeners prefer moveable or sliding sashes in a sloping roof; some prefer ventilating apertures in a roof of fixed sashes; others prefer large windows at the end of the house, and small ventilators in front; others prefer ventilators near the top of the back wall, and corresponding ones in the lower angle of the front; and those who have curvilinearly roofed hothouses have no choice of sashes, and must content themselves with some arrangement of numerous ventilators. The worst of all these methods is the contrivance of ventilators in rear and in front; and quite or very nearly the best, when the slope of the roof and the general plan of the building are proper, is the good old method of sliding sashes.

"The quantity of air to be admitted from time to time," remarks Dr. Neill, "must vary with the season, the temperature required to be kept up, and the kinds of plants cultivated. It should be given and withdrawn by degrees, particularly in the colder portions of the year. The sashes or ventilators, for instance, may be partially opened by eight A. M., top air being given before front air; full air may be employed about ten; a reduction should take place before three P. M.; and the whole should be closed between four and five in the afternoon. In summer less caution is necessary, as in many cases the external air differs little in temperature from that within the house. Most commonly air is given only during the day, and is excluded at night, with perhaps an increase of fire heat. Judicious horticulturists will sometimes reverse this process. Knowing, for example, that in the West Indies chilly and cold nights usually succeed the hottest days, they will imitate nature, by shutting up the house by day, and throwing it open at night. This practice, however, supported as it is by analogy, is subject to many limitations, and can only be followed in our climate during the summer and autumn months. It is useful, notwithstanding, to remember the principle, though it admits only of partial application." But in cold days, during the growing season, the sashes or ventilators ought not to be longer open than to admit a full supply of fresh air,—and they may accomplish this purpose in at most one hour, and sometimes in less than half an hour; and in very fine warm mornings, they may be opened as soon as the exterior temperature rises above 70°.

The interior temperature of the moist stove hothouse, and of the warmest kind of dry stove hothouse, during the whole of the growing season, except in rare cases or at special junctures, ought never to fall below 60° in the night, or to rise above 85° in the day. The chief exception is at the times of syringing, when, if the direct rays of the sun do not fall upon the plants, the temperature may safely rise to 90° or 95°. But during the season of hybernation, extending through November, December, January, and February, when the plants ought to enjoy complete repose and be almost or altogether torpid, the temperature ought never to rise higher by day than 60°, and ought always to be as low by night as about 50° in November and February, and from 50° to 55° in December and January.

The watering of dry stove plants must be considerably less copious than that of moist stove plants; and that of thoroughly succulent dry stove plants, such as the Cacteæ and many species of Euphorbia and Stapelia, must be considerably less copious than that of partially succulent dry stove plants, such as Cerbera, Columnea, and Plumiera; and again that of the latter must be considerably less copious than that of delicate, slow-growing, shrubby dry stove plants, such as Cinnamomum, Pimenta, Carolinea, and Poinciana. The syringing also must be modified in corresponding adaptation to the several classes. But in what we have further to say respecting watering and syringing, we shall refer exclusively to moist stove plants.

Watering, throughout the season of hybernation, ought to be very sparing in quantity, and given only when the soil becomes visibly dry; for if it were copious, it would combine with the lowness of the temperature to destroy all the most delicate plants, and more or less to injure the rest. During March, April, and May, the supply of water to the roots must be increased; in June, July, and August, it must be given in abundance; and from the end of August till the commencement of hybernation, it must be gradually decreased. An early hour in the morning is the best time of the day for watering, from the beginning of September till the end of May; and some hour in the afternoon, from the beginning of May till the end of August. The syringing of the plants overhead, for the purposes of keeping them clean and generally promoting their health, ought to be practised once a-week in September, twice a-week in the months of spring, and thrice a-week in all dry and hot weather of June, July, and August. "The proper time for syringing during spring and autumn," say the authors of the work on the Blight of Flowers, "is early in the day, that the moisture may have time to dry up; for, if otherwise, the nights being sometimes damp and cold, the lives of some of the more delicate species are endangered, from the chilliness occasioned by a superfluity of moisture. But the best time for syringing, during the hot months of summer, is in the afternoon. The reason of the afternoon being preferable to the morning at this season of the year, is, that the influence of the sun being great, there is danger, if the plants were wet in the mornings, that the leaves and stems of the more tender kinds might be scalded, because the direct rays of the sun would be upon them too early, before they could be sufficiently dried; also the plants are greatly benefitted by the house being kept closed for some hours after the operation, which could not be safely done early in a hot summer's day; for, although the roof might be shaded to prevent injury from the sun, yet the morning air would then be totally excluded from the plants, than which a greater loss could not be experienced. The advantages of syringing in an afternoon, during the summer months, are fourfold: first, the plants have all the benefit of the morning air; second, there is no danger of the stems or leaves scalding from the powerful influence of the sun; third, the house can be kept closed without any damage for many hours; and fourth, the great moisture in the house, during a hot summer's night, recruits the exhausted powers of the plants, and resembles, in some degree, the heavy dews of tropical countries."

HOTTENTOT CHERRY. See CASSINE.

HOTTENTOT FIG. See MESEMBRYANTHEMUM.

HOTTONIA. See FEATHERFOIL.

HOT-YELLOWS. A disease in the liver of sheep. It seems to arise from obstruction of the bile, or from a morbid or comparatively inactive state of the liver; and is sometimes accompanied with great fever,—and sometimes with symptoms like those of putridity. The proper treatment of it depends on the particular character of the symptoms, and may be gathered from the articles LIVER, FEVER, and INFLAMMATION.

HOUND,—*Canis sagax*,—one of the varieties of spaniels, distinguished by its long, smooth and pendulous ears. The BLOODHOUND is separately described, and appears to have been the origin of the other sub-varieties, the principal of which are the fox-hound, harrier, and beagle. England, perhaps, excels all other countries in her breed of hounds, not only from the climate being congenial to them, but also from the great attention paid to their breeding and management. The points of a good hound are thus laid down:—His legs should be perfectly straight, his feet round and not too large, his shoulders back, his breast rather wide than narrow, his chest deep, his back broad, his head small, his neck thin, his tail thick and bushy. As to the size, most sportsmen have their prejudices, some preferring them small, and others large; for general service, however, it appears that a medium is the best; this is the sentiment of Somerville:

> "For hounds of middle size, active and strong,
> Will better answer all thy various ends,
> And crown thy pleasing labours with success."

It is very essential that all the hounds in a pack should run well together; to attain which they should be of the same sort and size. The management of hounds may be considered as a regular system of education, from the time they are taken into the kennel. The feeding of a kennel of foxhounds is one of the most striking illustrations of the power of training to produce complete obedience. The feeder stations himself at the door, and calls each dog individually; the animal instantly advances; the rest, however impatient they may be, remaining quiet till their turn arrives. In these kennels, a barbarous custom of these dogs towards each other has sometimes been observed. If a hound gets down of his own accord from a bench on which he has been lying, no notice is taken of it by the others; but if he should unfortunately fall from the bench by accident, his companions fly at him and worry him to death. The beagle is the smallest of the dogs kept for the chase, and is only used in hunting the hare, and, though far inferior in speed to that animal, will follow, by its exquisite scent, with wonderful perseverance, till it fairly tires the hare. The harrier differs from the beagle in being somewhat larger, as well as more nimble and vigorous; they are also used almost exclusively in the chase of the hare. One of the most extraordinary hunts of this animal took place in England some years since, showing the perseverance of her pursuers. After a hard chase of 16 miles, the timid creature, finding herself closely pushed by the dogs, took to the sea, and, being followed by the whole pack, after braving the ocean for near a quarter of a mile, fell a sacrifice to her stanch pursuers, and was brought safe on shore by one of them.

HOUND'S-TONGUE, — botanically *Cynoglossum*. A genus of ornamental, herbaceous plants, of the borage tribe. The common or officinal species, *Cynoglossum officinale*, is a biennial indigen of the waste-grounds, road-sides, and rubbishy spots of Great Britain. Its root is tapering and fleshy; its stem is furrowed, hairy, branched, leafy, and about two feet high; its leaves are downy, very soft, and of a dull green colour,—and, when touched, they emit a pungent and disagreeable odour "like that of mice in a trap;" and its flowers grow in panicled clusters at the top of the stem, and have a dull crimson or purple and red colour, and bloom in June and July. This plant is eaten by goats, bnt is disliked by all other domestic animals. Its roots have astringent and narcotic properties, and possess reputation with herbalists as antiscorbutics, and, says Miller, "are gathered by the herb-folks in the fields." But the plant has no place among the materia medica of regular practitioners; and is too ticklish to be safely used by quacks.—The wood hound's-tongue, *Cynoglossum sylvaticum*, is a biennial indigen of shady-lanes, road-sides, and hedge-banks in some parts of Britain; but is vastly more rare than the preceding species. Its stem is about 3 feet high; its leaves have a bright shining green colour, and are free both from downiness and from bad smell; and its flowers bloom in June and July, and have at first a somewhat reddish colour, but afterwards change to a dull blue.—Nearly a score of species—two or three of them annuals, three or four perennials, and all the rest biennials—have been introduced to Britain from Southern Europe, the Levant, North America, and other places of similar climate; and most have flowers of some shade of blue, red, or purple, and make a good figure in the open border of the flower-garden. The blue-flowered, stem-clasping, perennial-rooted species, *Cynoglossum amplexicaule*, is best propagated by division of the roots; and all the other species are readily propagated from seeds.

HOUSE-BOTE. An allowance of timber out of the landlord's woods, for the repairs of the tenant's house.

HOUSE-CRICKET. See Cricket.

HOUSELEEK,—botanically *Sempervivum*. A genus of ornamental, evergreen plants, of the crassulaceous order. Upwards of 30 species occur in the gardens and botanical collections of Britain; some of these are very common, and in general request for rockwork; about a dozen are hardy, perennial herbs, and deserve a place in every extensive collection, and thrive well in almost any kind of dry rocky situation; and the others are evergreen shrubs or undershrubs, and require the heat and protection of a greenhouse or a conservatory. The herbaceous kinds are best propagated by divisions or foliage offsets; and most of the ligneous kinds by cuttings.

The common or roof houseleek, *Sempervivum tectorum*, grows on the tops of houses and walls in almost all parts of Britain, yet is not a native of this country. The leaves are numerous, succulent, fleshy, and very thick,—convex on their outer surface, plain in their inner surface, sharp in their point, and finely pubescent in their borders,—spreading, open, lying close to the soil, growing together in a circular agregation, and sending out on every side offsets of their own form; the stem or flower-stalk rises from among the aggregation of leaves, is garnished at the bottom with a few narrow leaves, is cylindrical, succulent, reddish, and about a foot high, and divides at the top into two or three parts, each terminating in a spike or range of flowers, and reflexed; and the flowers have each several small, reddish, or flesh-coloured petals, which spread open, and terminate in acute points,—and they bloom from June till September, and are succeeded by small horned capsules, full of little seeds. If offsets of this plant be stuck into mud or strong earth on a house or wall, they will grow or thrive without any further care. The juice of the leaves has the reputation of being a speedy remedy, either by itself or mixed with cream, for burns or other external inflammations.

The globiferous houseleek, *Sempervivum globiferum*, grows wild in the northern parts of Continental Europe; and was introduced to Britain in the former part of last century. Its leaves are much narrower, and grow more compactly, and in larger aggregations, than those of the common species; its foliary offsets are globular, turn inward at the top, lie close over one another, and are thrown off from between the larger heads of leaves, and fall upon the ground, and there take root, so as very rapidly to propagate the plant; its flower-stalks are smaller than those of the common species, and usually have a height of only about half-a-foot; and its flowers have a pale or yellowish colour, and bloom in June and July.

The cobwebbed houseleek, *Sempervivum arachnoideum*, is a native of the Alps of Italy and Switzerland, and was introduced to Britain about the end of the 17th century. Its heads or aggregations of leaves are small and very compact; its leaves are grey, sharp-pointed, and comparatively short and narrow, and are webbed together by an intersecting series of slender, white, filiform fibres, somewhat similar in appearance to a cobweb; its flowers are succulent, cylindrical, and about half-a-foot high, and are garnished with succulent, awl-shaped, alternate leaves, and divide each at the top into two or three branches; and its flowers are produced in single rows upon the branches, and have each eight spear-shaped petals, of a bright red colour, with a deep red longitudinal line along the middle, and bloom in June and July. Two beautiful varieties of this species, known as the major and the minor, are in cultivation.

The tree houseleek, *Sempervivum arboreum*, grows wild at the Cape of Good Hope and in the Levant, and abounds on old walls about Lisbon and other parts of Portugal, and was introduced upwards of two centuries ago to Britain. Its stem is smooth and fleshy, divides into many branches, has a light brown bark, is marked with the vestige of fallen leaves, and rises to the height of 8 or 10 feet; its leaves grow in round heads or clusters on the top of the branches, and lie over one another like the petals of a double rose, and are succulent, and spear-shaped, and of a bright green colour, and have very small indentures like the teeth of a very fine saw upon their edges; and its flowers rise from the centre of the heads, and form a large pyramidal spike, and have a bright golden yellow colour, and spread out their petals like the points of a star, and have a fine appearance, and usually bloom in autumn or winter, or even from March till December. A variety of this species with variegated leaves has long been esteemed by the curious; but it seldom attains more than half the height of the normal plant.

HOUSE-SPARROW. See SPARROW and HEDGE-BIRDS.

HOUSTONIA. A genus of ornamental plants of the madder tribe. The blue-flowered species, *H. cærulea*, is a native of North America, and was introduced about 62 years ago to Britain. Its root is fibrous and perennial; its leaves are evergreen; its flower-stem is about half-a-foot high; and its flowers have a lilac and blue colour, and bloom from May till August. It grows well in a light peat soil, kept somewhat moist in the open border; but is very liable to be thrown out of the ground by frost in winter; and if not so closely watched as to be replanted immediately after being thrown out, it may perish in the course of a few hours. But it does best in well-drained pots, in a soil of one half peat, one fourth sand, and one fourth light loam, kept in a shady situation out of doors in summer, and in a cold frame during winter; and if it be maintained in a somewhat moist state, and divided once or twice during the season, it will grow freely, and carry a profusion of flowers. Four or five other species were introduced between 1800 and 1838; and about a dozen additional species are known.

HOVE. See HOOVE.

HOVEA. A genus of ornamental, evergreen, Australian shrubs, of the broom division of the leguminous order. Upwards of a dozen species were introduced to Britain between the years 1795 and 1838; and nearly all these are handsome bushes, of 3 or 4 feet in height, with a profusion of showy blue or purple flowers, blooming from the early part of spring till the middle of summer, relishing a soil of sandy peat, and propagable from seeds or cuttings. The greater number take their specific name from some obvious peculiar character,—such as the linear-leaved, the long-leaved, the spear-leaved, the rosemary-leaved, the elliptic-leaved, the broad-leaved, the mucronate, the wool-bearing, the ragged, the shaggy, the curled, and the pungent. Three of the most beautiful are *Hovea Celsii*, introduced in 1818, about 4 feet high, and carrying elegant bright blue flowers from March till July,—*Hovea villosa*, introduced in 1829, about 3 feet high, and carrying handsome lilac flowers in April,—and *Hovea Manglesii*, introduced in 1836, about a foot high, and carrying purple flowers in the middle or latter part of winter.

HOVEL. An erection somewhat similar to a shed, open at the sides, and covered overhead, for affording shelter to farm-labourers while performing limited kinds of out-of-door work during falls of snow or rain.

HOVEN. See HOOVE.

HOVENIA. A small genus of tender, evergreen, tall fruit-shrubs, of the buckthorn tribe. Two species, the sweet and the unequal, the former Chinese, the latter Nepaulese, and both white-flowered and between 7 and 12 feet high, have been introduced to Britain.

HOVER-GROUND. Light ground.

HOYA. A genus of tender, ornamental, evergreen, twining plants, of the swallow-wort tribe. About 30 Indian species have been enumerated by botanists; but a number of these are very ill-known; and only 5 or 6 were introduced to Britain previous to 1837. Most of the introduced species attain a height of about 10 feet, and possess much beauty; and two, the fleshy-leaved and the thick-leaved, look, when not in flower, as if they belonged to the crassulaceous order. The fleshy-leaved, *H. carnosa*, was introduced about 45 years ago; and it has pinkish-coloured flowers, and blooms in July and August, and possesses a high degree of delicate and at the same time rather showy beauty. The leathery-leaved species, *H. coriacea*, was brought to bloom for the first time in Britain in 1838; and is a curious plant, nearly parasitical in its habits, and not sending out roots from its stem like the other species.

HUANACA. See ALPACA.

HUDSONIA. A genus of beautiful, evergreen, slightly-tender, North American undershrubs, of the cistus tribe. Three species, the woolly, the heath-like, and Nuttal's, all summer bloomers of about a foot in height, were introduced to Britain between the years 1804 and 1838. They love a soil of peat and sand or peat and loam, and are propagated by layering.

HUERNIA. A genus of curious-looking, Cape-of-Good-Hope, evergreen, dwarfish undershrubs, of the swallow-wort order. Nearly a dozen species were introduced to Britain about half a century ago; and all have a height of only a few inches, and carry striped flowers, and bloom either late in summer or in autumn, or in early winter, and thrive best in a mixture of sand and loam, and are propagated from cuttings.

HUGELIA. A genus of ornamental plants, of the polemonium tribe. Four species, all hardy annuals, and three of them blue-flowered and the other yellow-flowered, were introduced to Britain about 14 years ago from California.

HULLS. The husks or shellings of corn.

HUMATES. See HUMUS.

HUMBLE-PLANT,—botanically *Mimosa Pudica*. A very beautiful, dwarfish, evergreen, tender undershrub, of the mimosa division of the leguminous order. It is a native of Brazil, and was introduced to Britain in the former part of the 17th century. Its roots comprise a multitude of hairy fibres, and are matted close together in the ground; its stems are ligneous, and about a foot high, and naturally decumbent, but ought to be supported,—and they are armed with short-recurved spines, and garnished with pinnate leaves; its flowers are produced in short foot-stalks from the wings of the stems, and grow in small globular heads, and have a yellowish or whitish colour, and bloom from spring till mid-autumn; and its pods appear in close clusters, and are short, flat, jointed, and almost covered with stinging hairy covers, and contain each two or three orbicular, bordered, compressed seeds. This plant needs to be grown in a rich soil, and is propagated from seeds. See the article MIMOSA.

HUMEA. A beautiful, tall, Australian, biennial plant, of the vernonia division of the composite order. It constitutes a genus of itself, and is specifically called "the elegant." It was introduced to Britain nearly half a century ago; and it requires greenhouse heat, and is propagated from seeds, and grown in a mixture of sand and peat. Its stem is 6 or 7 feet high; and its flowers are red, and bloom from midsummer till the latter part of autumn.

HUMIC ACID. See HUMUS.

HUMIN. See HUMUS.

HUMMELLER. A mechanical contrivance for breaking off and clearing away the awns from barley. A powerful thrashing-machine, with merely the same mechanism and appliances which are used for wheat, is sometimes efficient for both the thrashing and the thorough hummelling of barley; or it may acquire a sufficiency of hummelling power, simply by having the thrashed barley put again through it, or by having the cover of its cylinder internally fluted, channelled, or roughened, and brought so near the beaters, that only a small space shall be left between them and the cover. But when the barley is not in prime condition, or is not all thoroughly ripened, or is mixed with any portion of clover or grasses, or is of a variety with very persistent awns, some express contrivance, of the specific nature of a hummeller, is indispensable for cleaning it.

One hummeller, comprising a number of varieties, and formerly in extensive use, consists of a scutching apparatus, enclosed within the cylinder of the thrashing-machine. The scutchers are adjusted upon a spindle, in the manner of several tiers or series of arms; the spindle, with the scutchers, is adjusted vertically within the cylinder, and made to revolve with great velocity; and the barley enters at the top of the cylinder, and sustains such a buffetting from all the tiers of scutchers as, in ordinary cases, completely frees it from its awns. But when the barley comprises a portion of unripe grains, or has an intermixture of grasses or clover, or is of a very persistently-awned variety, the cleaning, by this method, is very imperfect.

Another hummelling contrivance consists in cheap and easy appliances for retaining the barley within the drum-case of the thrashing-machine throughout the whole circumference of the case, and for subjecting it while there to numerously-repeated strokes of the drum's beaters. This contrivance seems to have been invented by Dr. Farquharson of Alford; and is described in the 13th volume of the Highland Society's Transactions. The special fittings for it cost only about £2, and are exceedingly durable, and consist merely of a slip-board, a small opening, and an apron. The slip-board is fixed, in grooves or by other temporary means, between the posts of the mill-framing, and rests on the edge of the bar which forms the breast of the grating or riddle under the shaker, so as completely to close up, for a time, the passage between the drum-case and the shaker. The small opening is made on the opposite side, immediately under the feeding rollers, and serves to let the grain escape, and fall down under the feeding-in bench. The apron is placed under the drum, and concentrically with it; and is formed on the same principle as the fluted or channelled hummelling cover of the drum, in lieu of the plain and ordinary cover. The interior surface of the apron presents a series of parallel angular channels, each about one inch deep, and three inches wide, and has the narrow faces of the channels, or those opposed to the direction of the motion of the drum, armed with strips of hoop-iron; and it is secured in its place by means of two screw-bolts at each end, passing through the circular bars of the apron and the posts of the framing. This apron is so adjusted that it can be fixed at different distances from the drum suitable to the varieties of barley and to other grains; and it does not interfere with common thrashing,—and, except when seed-corn is to be thrashed, seldom needs to be removed. But during common thrashing, the small opening under the feeding-rollers must be closed up by a slipboard, so that the grain may not be thrown out to the annoyance of the workmen; and during the process of hummelling, a skreen must, for a similar reason, be attached under the feeding-in bench.

An improved variety of Dr. Farquharson's contrivance came very early into use in Fifeshire, Kinross-shire, and perhaps some other districts. In this variety, the apron is dispensed with as quite unnecessary, and the slip-board is usually fitted to slide easily up and down in grooves at the ends, and can be raised or lowered at pleasure by means of a rope attached to it, and passing over a small pulley, and hanging within the reach of the feeder-in. When the slipboard is let down, a quantity of barley is allowed to pass into the drum-case by means of the rollers; and it is there retained under the impetuous action of the beaters as long as the feeder-in thinks proper; and when he considers it to be sufficiently rubbed and buffetted, he suddenly pulls up the slipboard, so as to allow the whole quantity of barley to be thrown, at one dash, upon the first shaker; and it then falls through the riddle, and is freed from the hummellings in the winnowing-machine, and comes out well-cleaned barley. This method possesses the advantages over Dr. Farquharson's of giving any degree of hummelling which the particular condition of the barley may require, of breaking off the awns, not by attrition only, but by a combination of percussion and attrition, and of afterwards clearing away the refuse by the action of the winnowing-machine.

A hummeller of another kind, though constructed on a general principle which previously had been often proposed and practised, was invented by the Messrs. Grant of Granton in Aberdeenshire, and is reported on in the 10th volume of the Highland Society's Transactions. It may be generally described as a truncated conical receiver, lying in nearly a horizontal position, furnished internally with a many-armed and rapidly-revolving axle, and made to scutch and buffet the barley on its way to the winnowing-machine. The exterior of this hummeller is a deal box, in the form of a truncated quadrangular pyramid, 30 inches on the side at the base, 20 inches at the smaller end, and 48 inches in length. The two lower angles of the interior are filled up with wood, so that the half of the interior surface is conical; and the two upper angles have their surface thickly studded with iron spikes, driven into the wood of the box. The axle or shaft is made of iron, and passes along the centre of the interior of the box, in the line of the axis of the conical surface, and is supported at the ends on bearers formed in the box's end bars; and it is armed with two rows of blunt iron beaters, seven in each row, all lying in one plane, and those of the one row placed alternately with those of the other. When the hummeller is in a working position, an opening at the smaller-end extremity of its upper side is brought under the cover-spout of the thrashing-mill winnowing-machine; and a prop or foot is placed beneath the same extremity of the under side, so as to bring the axle to a strictly horizontal line. A shaft is attached to the projecting end of the axle, passes through the winnowing-machine, and is connected at the further side with a pulley, which is driven by a strap from the fan-shaft or from such other motion as may be found convenient, and causes the beaters of the hummeller to move round with the velocity of about 400 revolutions in the minute. The barley received from the spout of the winnowing-machine is violently agitated in its progress among the revolving beaters; and it passes down the considerable inclination of the interior of the hummeller, to the thick-end extremity of the lower side, and is there discharged through an orifice, which is made capable of regulation by a slider, so that barley easily cleaned may be speedily let pass, and barley difficult to be cleaned may be retained till it undergo sufficiently prolonged tossing by the beaters. This hummeller has no permanent fixture in juxtaposition with the thrashing-mill, and can be easily removed when other kinds of grain than barley are about to be thrashed.

An improved and very greatly modified form of Grant's hummeller is now the most economical and the most efficient in use. The box or case of it is a cylinder, and has a vertical position; and its axle is armed with two rows of alternately-placed, thin iron-blades, and traverses the middle of the box from end to end so as to be strictly perpendicular, and to sweep the whole space with its arms, and is caused to revolve at the rate of between 300 and 400 revolutions in the minute, by means of any convenient connexion with the general moving power of the thrashing machine. The barley enters through a hopper at the top; and it does not pass among the arms as in Grant's hummeller, but always accumulates in such quantity as to keep the cylinder full; and it is discharged at the bottom, through a small orifice, of variable capacity, and so formed as to control the rate at which the barley passes, and consequently the degree in which it is hummelled. This machine admits of great variety in the details of construction,—particularly in the size of the cylinder, the form of the arms, the adjustment of the arms upon the axle, the position and form of the hopper, and the mode of connexion with the moving-power of the thrashing-machine; but in all its best varieties it is cylindrical, and vertical, and has flat or bladed arms, and works with a repletion of barley.

Another form of hummeller, sufficiently different from the preceding to be regarded as belonging to a distinct type, though also constructed on the general principle of Grant's, is described as follows by Mr. Ransome:—"The best machine we have seen is one upon a wooden stand, with a hopper into which the barley is thrown, from whence it falls into a box in which a spindle is placed in an inclined position, having, when at a few inches apart, short knives placed spirally, so as to form a sort of screw, which, when put in motion, has a tendency to draw the barley from the upper end of the box to the lower. During the operation the awns of the barley are effectually knocked off. This mode of dressing barley constitutes one of the principal improvements in Salter's patent winnowing-machine." See the article WINNOWING-MACHINE.

When the thrashing-machine is not used, or has imperfect power, or is unprovided with any hummelling apparatus, some kind of hand-hummeller requires to be employed. One variety of hand-hummeller has a flat face somewhat like that of a gridiron, and is worked vertically upon a thick layer of barley, and breaks off the awns by a series of blows. Another variety, nearly akin to the preceding, consists of a set of small iron plates, fixed edgewise and parallel to one another within a frame, and has an upright shaft terminating in a cross-handle, and is worked upon layers of barley on the barn-floor somewhat in the manner of a paver's instrument. A third variety has the outline of a miniature garden roller, but with the cylinder of its roller formed of thin, flat, wrought-iron bars, edged on the surface, and about two inches distant from one another; and it performs its office by being rolled upon layers of barley. A fourth variety, somewhat akin to the third, consists of a small cylindrical wheel, with an attached handle; and is rolled backward and forward upon rather thick layers of barley.

HUMULUS. See HOP.

HUMUS. The woody or fibrous parts of dead plants in a state of decay in the ground. It is not uniform in composition; it has been extensively confounded with some products of the action of alkalies and acids on sugar and woody fibre, which seem to resemble it but are really different from it; and, as to at once its constitution, its properties, and its action within the soil and upon growing plants, it is a topic of varied and conflicting opinions among agricultural chemists.

In 1797, the celebrated French chemist Vauquelin, while analysing the brown exudation from the common ulcers of the bark of the elm, discovered a solid substance of a brilliant black colour, very brittle, insoluble in cold water, but very soluble in hot water, and giving it a yellowish-brown colour, much more soluble in alcohol and in concentrated sulphuric acid, and capable of being precipitated from solution in either of these by the addition of water. In 1802, the Swedish chemist Klaproth received from Palermo a specimen of this substance; and, upon analysing it, he confirmed Vauquelin's observations, and found the substance to contain a portion of resinous matter. In 1810, Berzelius, the most acute chemist of the age, when experimenting upon the barks of various trees, found products similar to Vauquelin's substance in elm bark, Peruvian bark, and pine bark; and pronounced the first to be only a variety of vegetable mucilage, the second to be somewhat similar to starch, and the third to be allied to what is called pectic acid. In 1812, James Smithson, an English chemist, gave to the Royal Society of London an account of experiments which he had made on specimens of elm exudation received from the same person who had sent the specimen to Klaproth; and he reported the substance which he obtained from the specimens to be allied more to extractive matter than to resin, and to contain 20 per cent. of potash. In 1813, Dr. Thomas Thomson, the distinguished British chemist, experimented on several varieties of the gummy exudations of the bark of trees; and, assuming that one distinct vegetable principle pervaded them—or rather supposing himself to have converted a previous prevalent opinion on this point into an ascertained fact—called the alleged principle ulmin, from *ulmus*, the Latin name of elm. He was the first that ever procured ulmin in a pure state; and he proved it to be, not of a resinous but of an extractive nature; yet he illogically and confusingly identified it with all the varieties of substance obtained from barks by Berzelius,—not only with the several substances from the bark of the elm, but with the substances from pine bark and Peruvian bark.

Soon after ulmin had come to be generally recognised by chemists as a distinct substance, Braconnot found it in the soil formed in the hollow of a tree, in coal, and in a variety of brownish lignite; and he even produced it artificially by heating equal parts of sawdust and potash with a little water in a silver or iron vessel, and saturating the potash by sulphuric acid. The characters of his artificial ulmin were, that, when heated, it reddens the tincture of turnsole,—that, with potash and ammonia, it forms compounds which are very soluble in water, and decomposable by the acids, by lime-water, and by the earthy salts,—and that, in the course of a short time, it produces precipitates with the nitrates of baryta and silver, the chlorides of sodium and calcium, the trito-sulphate of iron, and the acetate of alumina. Dobereiner and Sprengel, on the faith of these characters, pronounced ulmin to be an acid; and both they and many other expert chemists instituted vigorous and comprehensive investigations into its properties and relations. Berzelius afterwards taught that ulmin is a constituent part of the bark of almost all trees; and other investigators declared it to exist in a vast variety of substances, — to be the product of very many vegetable decompositions by alkalies, by acids, by earths, by oxides, by fire, and by water,—to result very specially from the slowly reducing action of the oxygen of the atmosphere upon the organic matter of dead plants,—and therefore to exist abundantly in peat and in all kinds of soils which contain a considerable proportion of vegetable mould. Sprengel, directing his attention particularly to its existence in soil, before its character as occurring there was generally supposed to be identical with its character as occurring in the bark of trees, called it humic acid, from *humus*, the Latin name for mould. Boullay soon followed in the same path of investigation, and arrived at nearly similar results, and gave to both the ulmin of the early investigators and the humic acid of Sprengel the name of ulmic acid.

Yet the elm gum of Klaproth, the elm extractive of Smithson, the ulmin of Thomson, the artificial ulmin of Braconnot, the humic acid of Sprengel, and several of the varieties of the ulmin and the ulmic acid of other chemists, after all, were quite distinct from one another in constitution, and ought never to have been grouped together under one name. "A multitude of different but analogous substances," says Dr. Dana, "were confounded under a common name, which began to be applied to the matter of all vegetables, which, after being heated with alcohol and water, yielded to alkali a solution, precipitable in brown flocks by an acid." "In July, 1826," says M. Raspail, "I called the attention of chemists to the fallacious circumstances which had, so to speak, beguiled their sagacity; and I demonstrated that, instead of having obtained by these complicated processes a proximate principle, they had only given one or more new names to a mixture of altered bodies, and that even the acidity of these detritus might be altogether artificial. These observations appear to have shaken the confidence of Berzelius; for, in his Treatise on Chemistry, he advises chemists to lay aside the name ulmin, as having been applied to mucilaginous extracts of different kinds; yet, as if to make up for this, he invents a new name, geine, to designate the vegetable mould, or humus, which Braconnot had stated to resemble ulmin." But, at a subsequent period, Berzelius withdrew the name geine, and used instead of it the name humic acid; and from about the time of his doing so down to the present hour, all the principal agricultural chemists, inclusive of himself, though differing widely from one another in several of their definitions, in some of their theories, and in much of their nomenclature, have regarded humus as a generic substance comprising all the fibrous or organic parts of dead plants in a state of decay, and the natural or artificial modifications of it as specific substances of individually determinate and mutually different character. Some writers speak of the generic substance under the name of humus, some under the name of mould, and some under the name of geine; some regard as its principal species or modifications ulmin, humic acid, coal of humus, and humin, — and others, ulmin, ulmic acid, humin, and humic acid; some include among its species or modifications crenic acid and apocrenic acid, and others deny the very existence of these acids; and while some differ from others in theory, in definition, or in analysis, others differ chiefly or solely in mere nomenclature.

We cannot, within our necessarily narrow limits, attempt the enormous task of clearing up the intricacies of opinion respecting humus; we moreover, would think the task a thousand times more curious than useful; and we shall merely state two or three of the later and more important theories, and give a brief concluding statement of their connexion with the science of cultivation. Any person who wishes to see how much confusion and discrepancy sometimes prevail in the writings of even one author on subjects connected with humus, will find an ample enough specimen in Dr. Dana's Muck Manual, as reviewed in our article on GEINE.

Thaer says, "Humus is a mould, not properly an earth, but a powdery substance, in a greater or less degree found in the soil. The fruitfulness of the soil depends on its proportions, as likewise it is the only thing in the soil that gives nutriment to plants. It is the remains of vegetable and animal putrefaction—if dry, black and powdery; if moist, it has a smooth, fatty feeling. It is different according to the bodies out of which it is formed; but it has certain general peculiarities or properties in which it is essentially alike. Humus is a form of organic power, a combination of carbon, hydrogen, nitrogen, and oxygen, and also in lesser quantities of sulphur, phosphorus, and various salts,—gives nourishment to organism. The more life there is, the more humus; and the more humus, the more life. Humus has less oxygen, but more carbon and nitrogen, than the plants of which it is composed. It differs also as there is more or less water or air, as it is in a free or confined state. It is liable to changes, and forms extract or extractive matter. If it has not access to air, carbonic acid and extract are produced. Salts exist in a mass in humus. Humic acid by itself is unfruitful and injurious to vegetation. Humus differs as it is formed from animal or vegetable bodies. The animal has more nitrogen, sulphur, and phosphorus, as is perceivable by the smell it emits when burning."

Schwertz says, "The nourishing substance of plants, to which we give the name of humus, has the appearance of a powdery and usually a brown or dark grey loose substance, in which can no more be discerned its original condition. It burns in the fire, and is soluble in water, especially after an addition of alkali. It is not every decayed substance that is humus; and not every species of humus is in a condition for the fertility of plants. It forms itself from the soil more or less rapidly, according to the organic substances from which it is derived, the firmer or the less firm its texture is, the less or more earthly parts it contains, and as the circumstances of temperature and soil exert a stronger or weaker influence on the humus."

Burger says, "Humus will hold nearly double its weight in water without losing a drop. Schubler found that 100 parts of humus would retain 190 parts of water. Korte, also, found that a humus formed from the wild chestnut wood, would hold 239 per cent. of water, while a loamy clay held only 45 per cent. It loses the water also very slowly. According to Schubler, of 10,000 parts of water, 108 evaporated from humus in the same time that 245 escaped from 313 of garden earth. He fixes the power of humus to retain warmth at 0·49, while Crome sets it down at 0·72. It has little cohesive power. If set out in the open air, of all the integral parts of the soil it absorbs the most moisture. According to Schubler, 1,000 grains of humus in 48 hours absorbed 110 grains of water. According to Korte, in 4 weeks it absorbed six times as much moisture. Of all the constituents of the soil it is most easily decomposed in the air, and absorbs a great portion of its acids. According to Schubler, in a moist state, of 0·21 of oxygen existing in air, it absorbed ⅓ in 30 days. Humus combined with oxygen, is soluble in water; and a portion of the carbon of humus unites itself with the oxygen to form carbonic acid gas. It becomes warm, when set out in the sun, very rapidly and strongly; but it also very rapidly loses its acquired warmth. It is especially found in the upper strata of the earth."

Liebig says, "Humus appears to play such an important part in the phenomena of vegetation, that vegetable physiologists have been induced to ascribe the fertility of every soil to its presence. It is believed by many to be the principal nutriment of plants, and is supposed to be extracted by them from the soil in which they grow. It is described by chemists as a brown substance easily soluble in alkalies, but only slightly so in water, and produced during the decomposition of vegetable matters by the action of acids or alkalies. It has, however, received various names, according to the different external characters and chemical properties which it presents. Thus, ulmin, humic acid, coal of humus and humin, are names applied to modifications of humus. They are obtained by treating peat, woody fibre, soot, or brown coal with alkalies,—by decomposing sugar, starch, or sugar of milk by means of acids,—or by exposing alkaline solutions of tannic and gallic acids to the action of the air. The modifications of humus which are soluble in alkalies, are called humic acid; while those which are insoluble have received the designations of humin and coal of humus. The names given to these substances might cause it to be supposed that their composition is identical. But a more erroneous notion could not be entertained; since even sugar, acetic acid, and resin do not differ more widely in the proportions of their constituent elements, than do the various modifications of humus. Humic acid formed by the action of hydrate of potash upon sawdust contains, according to the accurate analysis of Peligot, 72 per cent. of carbon, while the humic acid obtained from turf and brown coal contains, according to Sprengel, only 58 per cent.; that produced by the action of diluted sulphuric acid upon sugar, 57 per cent. according to Malaguti; and that, lastly, which is obtained from sugar or from starch, by means of muriatic acid, according to the analysis of Stein, 64 per cent. Malaguti states, moreover, that humic acid contains an equal number of equivalents of oxygen and hydrogen, that is to say, that these elements exist in it in the proportions for forming water; while according to Sprengel, the oxygen is in excess; and Peligot estimates the quantity of hydrogen at 14 equivalents, and the oxygen at only 6 equivalents, making the deficiency of oxygen as great as 8 equivalents. Mulder and Hermann have shown that decayed willow-wood, peat, or vegetable mould, after being treated with water and alcohol, leave a solid brown substance, which yields to alkalies a peculiar humic acid. This humic acid consists of carbon and the elements of water. But besides these usual constituents, it contains a certain quantity of ammonia in a state of chemical combination. It is quite evident, therefore, that chemists have been in the habit of designating by the names of humic acid or humin all the brown or black coloured products of the decomposition of organic bodies, according as they were soluble or insoluble in alkalies; although in their composition and mode of origin the substances thus compounded might be in no way allied."

The part which humus plays, in fertilizing soil and feeding plants, is overrated to an enormous degree by most scientific cultivators in France and Germany, and to a very considerable degree by many scientific cultivators in Britain. Humus, in the form of humin or coal of humus, resists solution, and cannot possibly be absorbed by plants; and, even in the form of humic acid, occurs so limitedly or even doubtfully in the soil, and forms salts of such shy solubility, as to be incapable of contributing to plants any very appreciable portion, or perhaps any portion at all, of their nourishment. The ulmic and the humic acids indeed, have, of late years, been investigated and analysed with wondrous nicety, and shown to look amazingly like very suitable food for plants, by Mulder and other distinguished agricultural chemists; but they cannot be proved to exist in any considerable quantity, or even in many cases to exist at all, in the naturally conditioned soil, and must be supposed to arise more or less out of the chemical action attendant on the manipulations for investigating them. The saline combinations of humic acid with some alkalies, alkaline earths, and metals —called humates by some chemists, and geates by others—have been extolled by such writers as Dr. Dana as almost the main support of plants, or as the ready-made form of nearly all the food which they obtain from the soil. Dr. Dana, for example, says that all the alkaline geates are very soluble in water,—that geate of magnesia is soluble in 160 parts of water,—that geate of alumina is soluble in 4,200 parts of water, and abundantly soluble in alkali,—that geate of iron is soluble in 2,300 parts of water, and easily soluble in alkaline carbonates,—that geate of manganese is soluble in 1,450 parts of water, and, though insoluble in potash or soda, yet is soluble in ammonia,—and that geine itself, or humus, acquires a wonderful increase of solubility from the action of the alkalies, so as to be greatly and very valuably under the farmer's control simply by means of applications of alumina, or magnesia, or lime; and, on the strength of these statements, he indulges in not a few such flourishes as the following—alike inconsistent with the well-ascertained facts of agricultural chemistry, and mischievously misleading to the plain, unreasoning farmer,—"Geine is as essential to plants as is food to animals; so far as nourishment is derived from the soil, geine is the food of plants"! Our readers, we hope, will carefully read our articles ALKALIES, ALUMINA, and FOOD OF PLANTS, and the section 'Origin and Action of Humus' of our article AGRICULTURAL CHEMISTRY, and the section upon the action or theory of manures in our article MANURE; and then they can refute all this trumpery for themselves, and form an intelligent opinion as to both the manner in which humus really acts, and the amount, actual or imaginary, of its affinities for the mineral constituents of the soil.

If humus could be understood as including animal organic matters and fermenting or recently dead vegetable organic matters—if it could be understood in any such sense as Thaer assigns to it, when he calls it "a combination of carbon, hydrogen, nitrogen, and oxygen, and also in lesser quantities of sulphur, phosphorus, and various salts,"—it would unquestionably deserve to be called the main fertilizer of soil, and to be considered as a direct and very important portion of the food of plants; but, in this case, it would not be what Dr. Dana calls geine, or what the great majority of chemists call humus, or any one definite substance or generic set of principles whatever, but simply the aggregate of saline matters and nitrogenous matters and all sorts of soluble organic matters in the soil, ever diversifying according to season and culture, and statedly and incalculably various in different kinds and qualities of land,—in other words, it would simply be an aggregate expression for all the organic and saline principles of fertility in the soil, or for the manurial and the mineral food of plants. But even the humic and the ulmic acids which are elaborated out of the mould of soil, and which combine with bases to form those humates and ulmates—or geates, as Dr. Dana calls them—which are alleged to be absorbable by plants as food,—even these are regarded by all the most distinguished modern chemists as consisting solely of carbon, hydrogen, and oxygen. According to a statement in Berzelius' "Rapport Annuel sur les Progrès de la Chimie" in 1841, for example, humic acid consists of 40 atoms of carbon, 12 of hydrogen, and 12 of oxygen, and ulmic acid consists of 40 atoms of carbon, 14 of hydrogen, and 12 of oxygen. A certain quantity of ammonia, indeed, is believed to exist in chemical combination with these two acids as they are supposed to occur in the soil; but—to say nothing of this quantity being at one time double of what it is at others—the four elements of the ammonia and the acids are merely yielded from soil in proportions which would constitute these substances, and cannot be proved to exist as ammonia in combination with humic acid or with ulmic acid previous to the making of the analysis. Hence, when Berzelius reports some most careful investigations upon this subject, he feels obliged to employ very guarded language, saying, "These analyses prove that *fertile soils* contain combinations of ammonia with acids, *which correspond to* those of humic and ulmic acids,—in all containing 40 atoms of carbon, and a *variable* number of atoms of hydrogen and oxygen;" and Dr. Shier, after looking favourably at his whole report, ingenuously says, "The great difficulty attendant on the whole question of the organic matters of soils, is, that we can never be sure that the substances separated existed as such in the soils."

Now who shall surmount this "difficulty," much less annihilate it? Who shall prove that the humic and the ulmic acids, in any appreciable quantity at least, exist at all in soils? And if the acids cannot be proved to exist, where can Dr. Dana's geates—the humates and the ulmates —be found? But even though they could be found,—though the humic and the ulmic acids were conceded to exist, and to form salts with the alkaline and the metallic bases in the soil,—and though these salts, the geates, were supposed to possess all the properties which the advocates of their fertilizing action ascribe to them,—they could not possibly supply plants with anything like the quantity of carbon, to say nothing of other elements, which is known to be requisite for their growth. Liebig shows, for example, that, in the course of a year, one Hessian acre of woodland could not possibly secrete a larger quantity of dry wood from the richest and most favourable forms of humates than 165 lb., and yet that it is known actually to secrete 2,650 lb.,—that one Hessian acre could not possibly secrete from humates more than 85 lb. of woody fibre, and yet that it is known to secrete 1,780 lb. of straw, equivalent in composition to woody fibre,—and that, in short, vegetation of all kinds, on every description of land, either in a natural growth, or under cultivation, must necessarily obtain the whole bulk of all its carbonaceous principles, from the inhalation, imbibition, or absorption of carbonic acid, mainly from the atmosphere, and only limitedly from the soil,—so that, in even the small degree in which it is fed by humus, it receives the aliment, not in the condition of humates formed by the combination of humic acid with salifiable bases, but in the condition of carbonic acid formed by the reducing action of the oxygen of the atmosphere upon the carbon of the humus. The main or almost sole value of mould therefore—additional to the saline matters with which it may be mixed, and to the carbonic acid which it yields to the roots of plantlets between the time of germinating and the time of brairding—is to give due mechanical cohesion to soils of excessive pulverulency, and a requisite degree of absorptiveness and sponginess to siliceous sands and to other soils of excessive aridity. A large proportion of plants are well known to nurserymen and gardeners to love abundant peatiness of soil,—in other words, to demand a profusion of humus as essential to their vigour, and even in some instances to their existence; but these plants are not more voracious of carbon than others which live on thin gravels and almost on dry rocks; and they require to root and nestle and terrestrially ramify among humus, not at all in order to obtain humates or even carbonic acid from it, but principally, or perhaps solely, because it gives such texture to the soil as to make it a suitably retentive reservoir of the saline rains of heaven.

HUNDRED. A division of a shire or county. It was so called, according to some writers, because each hundred found 100 fidejussors, or sureties of the king's peace, or 100 able-bodied men of war. Others think it to have been so called because originally composed of 100 families. Hundreds were first introduced into England by Alfred. They seem to have previously existed in Denmark; and in France, a regulation of this sort was made, above 200 years before, by Clothaire and Childebert, with a view of obliging each district to answer for the robberies committed in it. Something like this institution may be traced back to the ancient Germans, from whom were derived the Franks, who became masters of Gaul, and the Saxons, who settled in England; for both the thing and the name, as a territorial assemblage of persons, were well known to that warlike people. By various statutes, hundreds are liable to actions for injuries sustained by riots, robberies, malicious mischiefs, &c.

HUNGARIAN LOTUS,—botanically *Nymphæa Thermalis*. A beautiful, white-flowered, perennial-rooted, tender, floating plant, of the water-lily genus. It was introduced to Britain nearly half a century ago from Hungary.

HUNGER ROT. A disease in sheep. It is also called pelt-rot and naked-disease; and may be regarded as a variety of the common rot. See the articles ROT and FLUKE. It differs from common rot, principally in having its main seat, not confined to the liver, but extended throughout all the viscera which are concerned in the preparation of the chyle. See the article CHYLE. The mesenteric glands are obstructed and swollen; all the secretions for the general sustenance of the system are stinted and sickly; the entire frame becomes gradually emaciated; the very wool ceases to receive nourishment, falls off, and leaves the skin bare; and, in the last stages of the malady, even the teeth and the horns become loose. A principal cause of hunger-rot is poor and unhealthy feeding, particularly during winter; and the best remedy, in any of the initial or the middle stages of the disorder, is cautiously to remove the sheep to good pasture.

HUNTER. See HORSE.

HUNTLEYA. A genus of tropical, epiphytous, magnificently-flowering plants, of the orchis order. It is nearly allied to Zygopetalum, and was named in honour of the Rev. Mr. Huntley, a zealous cultivator of orchidaceæ. The guinea-hen species, *H. meleagris*, was introduced to Britian from Brazil in 1838. It has a height of about a foot, and blooms in June. Its flowers are solitary, and grow on erect peduncles, and have a yellow ground-colour, with irregular blotches of brownish purple.—The violet-coloured species, *H. violacea*, was introduced a year or two later than the preceding, and considerably excels it in the properties most esteemed by a florist. Its flowers have a singular character, and an uncommon colour, and a profusely blooming habit; they have a finer form, a larger size, and a more imposing appearance than those of the guinea-hen species; they grow protrudedly on pendulous scapes; they possess a beautiful bluish-purple or violet hue, and have on their lip a curious crest; and they sometimes appear to the number of from four to six simultaneously on one plant,—they individually continue during several weeks,—and they bloom indifferently at almost any season, and may be coaxed out in succession at least six or seven times in the year.

HURA. See AJUAPAR.

HURDLE. One of a series of pieces of moveable fence. It may be made either of iron, of metallic rods and wires, of nets, of split timber, or of saplings, brushwood, and strong twigs; and it may vary in character and appearance, from the rudely rustic to the simply neat or the chastely ornamental.

Hurdles serve well as temporary fences for the home-farms or aration-courses of gentlemen's parks; for they are universally known to be temporary, and are easily and cheaply set down and taken up, and do not break or mar the home-views or near-scenery of the adjacent mansions. They are also preferable to any kind of common fixed fence, in situations which, while requiring to be enclosed, have no need of shelter; for they occupy less space than either hedge, wall, or ditch, and do not harbour birds, insects, or vermin, and afford no enticement to cattle to over-browse and over-manure the adjacent border of the enclosure.

But the main use of hurdles—particularly of the light, cheap, wooden kinds—is to form moveable folds for feeding off turnips or other green crops with sheep. "A shepherd and his dog, with the requisite number of hurdles, may feed off a hundred acres of turnips or other green crop, without other assistance than having the hurdles carted to the field. The number of hurdles required is one row the whole length of the ridges of an enclosed field, and as many more as will reach twice across two 8-step lands or ridges, or four 4-step lands. This number, whatever it may be, is sufficient for a whole quadrangular field, whatever number of acres it may contain. The daily portions are given more or less in length according to the number of the flock. Two of these portions are first set, the sheep being let in on the first or corner piece. Next day they are turned into the second piece; and the cross-hurdles that enclosed them on the first are carried forwards and set to form the third piece. These removes are continued daily till the bottom of the field is reached. Both the cross rows are then to spare, and are carried and set to begin a new long row, close to the off-side of a furrow; and the daily folding is carried back over two or four lands as at first. It is always proper to begin at the top of a field, if there be any difference in the level, in order that the flock may have the driest lair to retire to in wet weather. Where there is a mixed flock, that is, couples, fattening, and store sheep, two folds or pens are always being fed off at the same time, which only requires an extra cross-row of hurdles. The couples have the fresh pen, while the lambs are allowed to roam over the unfolded turnips, by placing the feet of the hurdles here and there far enough apart, or by lamb hurdles made with open pannels for the purpose. The fattening sheep follow the couples, and have the bulbs picked up for them. The stores follow behind to eat up the shells. Thus the business of feeding-off turnips is done pleasantly and regularly. The shepherd's task is easy: carrying and setting a few hurdles and picking up the roots are his daily business; and the whole flock being constantly under his eye, whatever is amiss is promptly remedied. A boy is sometimes necessary to assist in picking up the roots." See the article Sheep.

When hurdles are to be set up, they are carted into the field, and laid down flat, and in regular series, or end to end, with their heads adjacent to the line of the intended fence; a large iron dibble, about four feet long, with a bit well-pointed, flattened, and similar in shape to the feet of the hurdles, is used for making holes about 9 inches deep, in which to set them; and a man uses the dibble with his right hand, measures the distances from hole to hole without the aid of any rule, and sets in the hurdles with his left hand, all so expeditiously that he would have twelve hurdles adjusted in their places before we could describe the manner of his adjusting two. He commences close to the fixed fence at the side of the field, makes a hole for the first foot of the first hurdle, marks the spot for the second hole, makes that hole, lifts the hurdle, inserts its two feet into the two holes, and, while holding it upright, lightly presses it down with the left foot on the lowest slot. He then makes the first hole for the second hurdle at the distance of about six inches from the second foot of the first hurdle; and then proceeds as before, from hole to hole and from hurdle to hurdle, till he has set up a whole row of hurdles or complete line of fence. When the first hole of a hurdle is made, the dibble is put out of hand, by being stuck in the ground near the place of the second hole; and when the place of the second hole is ascertained and marked, the hurdle is moved out of the way by the left hand till the hole is made; and whenever the soil is in any degree stiff, both hands are used in driving the dibble. After the row is set, the workman passes from end to end of it, and gives each head a slight stroke with the bit of the dibbler, sufficient to render the hurdles somewhat uniform in height, and to give them a firmer hold of the ground; and either he or an assistant afterwards places a wreath or coupling of willow-twigs or of any other withes, about five inches in diameter, over the adjoining hurdle-heads at each junction, so as to keep the whole line steady against the action of strong winds and the abrasion of the sheep.

In England, poles for hurdles are grown sometimes in hedges, sometimes in enclosed pieces of underwood, and, more commonly, on willow-grounds in meadows or by the sides of ditches or watercourses. In fact, every English farmer, who lives in a well-wooded country, or who has within his farm any piece of ground suitable for the growth of the common crack-willow, *Salix fragilis*, either has, or may have, a sufficiency of material to keep up a stock of as many hurdles as he can require; and he may have them made either by his shepherd or other farm-servant, or by itinerant professional hurdle-makers, who find their own tools, and work at very reasonable rates.

"A hurdle-maker's tools," says Mr. Main, "are a hand-saw, light hatchet, draw-shave, flamard, a centre-bit and stock, a tomahawk and gimlet. He has also a rending frame, which is a common trestle, on which two strong poles are laid, leaning and connected by a piece called a bridge. Besides this he has also a contrivance for shaving his poles, &c. In doing this, he takes advantage of a door or gate-post, or of an old worthless stem of a tree; or, if none of these offer, he must place a strong post in the ground for the purpose. In this post, two auger holes are bored, to admit two stout square iron stubs, having ears to assist withdrawing them when done with. The stubs project from the surface of the post about 6 inches, let in about 3 feet from the ground, and 8 inches from each other, though not exactly horizontally, the one nearest the workman being rather higher than the other. The use of these stubs is for forming a vice to hold the poles while they are shaved; being at the same time supported by a standard about 3 feet from the post, and having a sharp short spike on the top to steady the pole under the action of the draw-shave. In the same post a square staple is driven to hold the feet of the heads while they are mortised, assisted by a low stool. All these things being ready, the poles are prepared for the different purposes to which they can be converted. The butt-end of the pole is first shaved-off: 4½-feet lengths make a pair of heads; 9-feet lengths make a pair of slots; 5-feet lengths make a pair of stay-slots; 3½-feet lengths make a pair of uprights. The next proceeding is rending the different pieces: this is done at the rending-frame. The piece is put over the bridge with the butt-end upwards. The flamard is placed across the pith and driven down with a wooden baton. When entered down a foot or two, the pole is brought up to bear upon the bridge, and at the same time on the under side of the top of the trestle. The pole being kept down by the left hand, while the flamart is guided by the right, by bending and turning the pole, the cleavage is performed from end to end with great exactness. In this way all the different pieces are cloven. They next undergo a little chopping or hewing with the hatchet, to cut off knots on the outside, keeping the inside as straight and square as possible. The next operation is shaving off the bark and all irregularities, and giving each member its proper form. The maker next proceeds to form the hurdles: 4 low stumps are driven into the ground to mark the length, and 4 others to mark the distance between the upper and lower slots: a pair of heads, one at each end, are laid down in their right position, the flat or pith side upwards; the 6 slots are then laid at due distances upon the heads, and the latter are 'soubed' to the size of each slot, to regulate the mortises. One of the heads is then placed on the staple before mentioned, and resting upon the top of the mortising-stool, to which it is fixed in an opening by a wedge, the centre-bit and stock drills out a hole at each end of the mortises, and also one for the diagonal brace slot, about 2 inches below the lowest slot, and a little out of the line of the mortises above. It will be observed that mortises made by the centre-bit leave an intermediate piece between the apertures: this is taken out by the tomahawk, a tool made for the purpose. One end is a sharp, stout pointed knife, which cuts each side of the middle piece left in the mortise, and the other end hooks out the piece if not dislodged by the knife. This head is now hammered on to the slots; and the other head is prepared, and hammered on in the same way. The top and bottom slots are next nailed to the heads, and then the upright slot exactly in the middle. The two stay-slots are cut with a bend at the bottom, and rather sharply pointed; the point is driven through their oblique mortises, and their heads brought up to bear on the top of the upright, and nailed to each slot from top to bottom. The hurdle is then raised on its feet, and the nails clenched, which finishes the business. The gimlet is used for every nail, and a small block of wood is placed under each slot while the nail is driven. This description makes hurdle-making appear a very tedious affair; but, in fact, it is not so. It is astonishing how soon an expert hand will put together a pile of hurdles, one dozen being an ordinary day's work of 9 or 10 hours, and sometimes more if the stuff be clean and straight. The nails used in hurdle-making are of the best iron, and what are called "fine drawn," not square, but rather flattened, to facilitate clenching, on which much of the strength of the hurdle depends; the head of the nails is rather large, their price is 6d. per pound. One hundred poles at 18s. make three dozen hurdles, which, including nails and workmanship, amount to £1 11s. 6d., or 10s. 6d. per dozen. Although the longitudinal slots are cut 9 feet long, the hurdle, when finished, is only somewhat more than 8 feet, the slot-ends going through the heads an inch or two. Two to a rod, or 8 to a chain of 22 yards, is the usual allowance."

Hurdles made of twisted hazel rods are very common in some districts of the south of England, and are cheaper at first than willow-hurdles, but do not last so long, and require more repair. Hurdles made of ash are greatly improved in durability by the charring of as much of them as stands within the soil. Net hurdles require to be kept quite dry when not in use, and occasion a comparatively large degree of trouble. Ornamental wooden hurdles can generally be formed at less cost of material, and sometimes at less total cost than ordinary wooden ones; for they are filled with small short pieces of wood of very little value. Hurdles of large size, called Park hurdles, are employed for subdividing meadows or pastures, and have sufficient strength to serve as a fence against cattle. Iron hurdles may be made of many varieties; and are peculiarly suitable, by their light and elegant appearance, for the fences of lawns, of parks, or of the home-farm of an estate. A series of wire hurdles, in the form of a small quadrangular enclosure, mounted upon little wheels, for confining a small number of sheep upon spot after spot of the lawn of a flower-garden or pleasure-ground, so as to harden and manure its surface, and to substitute the clipping of its grass with the teeth for the cutting of it with the scythe, was invented by Mr. Buist, the inventor of the wire-gates. See the article GATE. The wire enclosure or cage is 18 feet long and 9 feet wide; its framing is of light bar iron; its filling-up is of wire of the thickness of a small goose quill; it is supported at the corners by four universally moving castors; and one end of it opens and shuts in the manner of a door. It may be made for about £3; it is rather ornamental than otherwise upon a pleasure-ground; and it serves well for two or at most three sheep, and may be readily moved from spot to spot of a lawn till the whole shall acquire a fine and smooth surface.

HURDS, or HORDS. The coarser parts of flax or hemp, separated in the process of dressing from the finer parts.

HUSBANDMAN. A general farmer. Every husbandman attends more or less to all the departments of farming or of practical agriculture; while a farmer may attend to only some, or even to only one, of these departments. The occupier of a thoroughly mixed farm, which comprises corn-fields, pastures, meadows, woodlands, dairy, poultry-yard, and orchard, is a husbandman; but the occupier of a grazing-farm, a carse-farm, a dairy-farm, a hop-farm, or any other kind of farm of limited character, is not a husbandman.

HUSBANDRY. The occupation of a husbandman, or general attention to the produce of the soil. It comprises all departments of farming, forestry, and field-gardening in Britain, and all departments of care for the fruits of the earth, whether in rice-fields, vineyards, orange-plantations, cinnamon-groves, sugar-plantations, cotton-grounds, or other large arenas of vegetable produce, in other lands. See the article FARM and the GENERAL INTRODUCTION.

HUSK. The dried envelope of any kind of flower or seed or fruit.

HUTCHINSIA. A genus of ornamental, herbaceous plants, of the cruciferous order. Some of its species are nearly allied to the candytufts; others are very nearly allied to the common cresses; and most were formerly assigned to these two genera. The rock species, *Hutchinsia petræa*—called by the older botanists *Lepidium petræum* — is an annual indigen of walls and limestone rocks in some parts of England. Its root is fibrous; its stems are erect, branched, leafy, and about three inches high; its leaves are deeply and beautifully pinnated, and have a terminating odd leaflet; and its flowers grow in corymbs, and are white and very small, and have narrow petals and a sessile stigma, and bloom from March till May. Five evergreen herbaceous species, and one annual species, mostly white-flowered, have been introduced to Britain from Siberia, Carinthia, Germany, Switzerland, and the south of Europe; and 4 or 5 other species are known.

HYACINTH, — botanically *Hyacinthus.* A genus of ornamental, bulbous-rooted plants, of the asphodel family. Some of the species which formerly belonged to it are now assigned to other genera; and though eight or nine still belong to it, almost the whole interest of the genus is concentrated in the oriental species,—*H. orientalis.*

This has long been one of the most esteemed of florists' flowers; and it now comprises a vast multitude of very beautiful varieties. It is originally from the Levant, but has been brought to its present improved state in the Low Countries. Double hyacinths are now the most highly prized, though formerly these were as little sought after as double tulips are now, the beauty of the flower being then regarded as consisting in the regularity of the shape and disposition of the blossoms, and in the richness of the colour. Whole acres of nursery-ground are covered with this flower near Haarlem and Utrecht in Holland. Here new varieties are annually produced from the seed, which is collected from multiplicate or semi-double flowers, and from very fine single flowers. When a new variety of good qualities is procured, it is named and enrolled in the select list. The choice flowers are divided into classes, according to their colours. Joan Kreps and Sons of Haarlem enumerate near 1,000 varieties in their catalogue, classed in this way: Reds; rosy and flesh-coloured; white, with rosy and flesh-coloured eyes; yellow; white with yellow eyes; white with red eyes; pure white; white with violet and purple eyes; dark blackish blue; dark blue; porcelain and pale blue.

The stem of a fine hyacinth is tall, strong and upright; the blossoms are numerous, large, well filled with petals, so as to appear rather convex, suspended in a horizontal direction; and the whole flower has a compact pyramidal form, with the uppermost blossom quite erect. "Each pip or flower should be round and not ragged. The petals should be broad, thick, blunt at the ends, not pointed, and reflex enough to throw up the centre well. The footstalk should be strong, and hold the flower out stiff in a vertical position, that is, facing the spectator, and by no means weak, to allow the pip to hang with the face sloping toward the ground. The footstalks should also be of a length to make the pips touch each other and no more. The pips should be large, for unless the pips be large they cannot touch each other without very short footstalks, and the flowers would be so close to the stem, that the truss itself would be no size. Double flowers should have the rows of petals above each other very regularly imbricated, so as to throw up the centre. The outer petals, therefore, of a double flower need not reflex, and should not reflex so much as a single one, because the centre is raised by the second and third rows of petals. The spike should be bold, round, compact, and pyramidical, with a number of flowers at the bottom, gradually diminishing to a single flower at the top; and no part of the flower-stem should be seen from the lowest flowers to the top. The colours should be bright, clear, and dense, whatever the shade; and any better approach to scarlet, blue, or yellow, than those shades we now possess, would be highly esteemed; flowers with dark eyes, very clear outsides, and those with striped petals, would be held to be better than selfs in general, but would give no point against form."

The hyacinth grows best in a light, sandy, but fresh earth. If manure of any sort be given, it must be placed far below the bulb. The time for planting is from the middle to the end of September. Old tanners-bark is kept spread over the beds during winter, unless when mild weather seems to set in for some days. When the plants come into flower, a slight awning, which can easily be removed, is placed over them; and by this means they continue a month in glory. Hyacinths in beds never require any watering. When the flowering is over, the Dutch *move* their hyacinths with the spade, so as to break the root-fibres, and prevent farther nourishment, but do not raise them completely from the ground for a fortnight. Even then, they are laid in a bed nearly in a horizontal position, with their leaves and stems lying outwards; in this way, a great part of the juice in their thick succulent leaves and stems evaporates, instead of returning into the bulbs. This is called "ripening the roots." When choice hyacinths are cultivated in pots, as is commonly the case in this country, the pots are laid on their sides after the flowering till the leaves decay. Bulbs four or five years old, flower most strongly in Britain, and they then gradually fall off; but in Holland they endure a great number of years. It is remarked that they succeed best in situations near the sea. It is curious that bulbs imported from Holland flower more beautifully in this country the first year, than they ever do afterwards.

HYACINTH (Grape). See Grape Hyacinth.

HYACINTH (Wild). See Squill.

HYÆNA-POISON, — botanically *Hyænanche.* An ornamental, evergreen, Cape-of-Good-Hope shrub, of the euphorbia tribe. It was introduced to Britain upwards of 60 years ago; and it has usually a height of about 8 feet, and blooms from spring till mid-autumn. It constitutes a genus of itself, and takes for its specific name *globosa;* but it is called by some botanists *Toxicodendron capense.* The name *hyænanche* signifies 'to strangle a hyæna,' and the name *toxicodendron* may be translated 'the poison-tree;' and both sufficiently indicate the opinion which its discoverers entertained of its virulently poisonous properties. See the article Euphorbia.

HYBERNATION. That state of torpidity into which some animals fall during a part of the autumn and in winter, but from which they escape early in spring. Although we are wholly ignorant of the cause of this winter-sleep, the effects and design are well-known. It seems obviously intended to preserve the animals in situations where they could not have maintained their existence, from the impossibility of finding an adequate supply of food. Accordingly, all the active functions of life are suspended, where their exercise would be incompatible with more general laws.

At a more or less advanced period of the autumn, depending on the degree in which the temperature is lowered, animals possessed of this peculiar constitution seek to shelter themselves from the cold and wind, by retiring into holes excavated in the ground, walls, trees, or among the bushes. These retreats they line carefully with grass, green leaves, moss, and other bad conductors of heat. Hybernation occurs among several of the mammalia, as in the fat dormouse (*Myoxus glis*), the garden dormouse (*M. nitela*), the common dormouse (*M. avellanarius*), the hedgehog (*Erinaceus Europæus*), the bats, the Alpine marmot (*Arctomys marmota*), the hamster (*Cricetus vulgaris*), the jumping mouse of Canada (*Meriones nemoralis*), and some others. Animals with cold blood hybernate as well as some of the mammalia. Many reptiles become torpid in cold climates, as well as some insects, mollusca, and worms; but in general the degree of their lethargy is much less profound than that of the hybernating mammalia. They pass their time of hybernation without food, but are not always deprived of sensation and motion, even at the freezing point. "It is highly important," observes Dr. Marshall Hall, "to distinguish that kind of torpor which may be produced by cold in any animal from true hybernation, which is a property peculiar to a few species. The former is attended by a benumbed state of the sentient nerves, and a stiffened condition of the muscles; it is the direct and immediate effect of cold, and even in the hybernating animal is of an injurious and fatal tendency; in the latter, the sensibility and motility are unimpaired, the phenomena are produced through the medium of sleep, and the effect and object are the preservation of life. Striking as these differences are, it is certain that the distinction has not always been made. In all the experiments which have been made with artificial temperatures especially, it is obvious that this distinction has been neglected. True hybernation is induced by temperatures only moderately low. All hybernating animals avoid exposure to extreme cold. They seek some secure retreat, make themselves nests or burrows, or congregate in clusters; and if the season prove unusually severe, or if their retreat be not well chosen, and they be exposed, in consequence, to excessive cold, many become benumbed, stiffen, and die. To induce true hybernation it is quite necessary to avoid extreme cold, otherwise we produce the benumbed and stiffened condition to which the true torpor or torpidity may be appropriated. I have even observed that methods which secure moderation in temperature lead to hybernation. Hedgehogs supplied with hay or straw, and dormice supplied with cotton wool, make themselves nests, and become lethargic; when others, to which these materials are denied, and which are consequently more exposed to cold, remain in a state of activity. In these cases warmth, or moderate cold, actually concurs to produce hybernation."

The kind of retreat which each animal prepares varies with the species. The bats, besides hybernating in holes, also hang suspended in grottoes and caverns, where the temperature is milder than in the open air. Other hybernating animals are satisfied with bringing their head nearer to their lower extremities, so as to present a surface of less extent to the cold. On discovering them in their retreats they are found rolled up, cold to the touch, motionless, stiff, their eyes closed, their respiration slow, interrupted, scarcely perceptible, or none at all. Their insensibility is sometimes such that they may be moved, rolled about, and shaken in every possible way, without being disturbed from their torpor.

During the spring or summer, when these animals enjoy their full activity, they possess an elevated temperature, which may vary according to the species and individuals, between 95° and 98½° Fahrenheit, and consequently is between those limits which characterize the animals with warm blood. When examined in the autumn, with the view of ascertaining the changes which they then undergo, it is observed that their temperature falls rapidly as the cold season advances. Their respiration gradually becomes impeded, their movements are less rapid, and their appetite diminishes; but these animals still maintain the use of their senses and the power of locomotion. This intermediate state, between the full possession of life in all its vigour, and absolute torpidity, may continue for one or two months. The degree of external temperature at which they become absolutely torpid varies with the species, and even according to the individual. In general, the disposition to hybernate follows in a descending scale of temperature, of which the following is the order:—The bat, the hedgehog, the dormouse, the marmot, and the hamster. The comparison has, we believe, not yet been instituted for the other species. Although there is no precise degree at which these animals lose the faculties of sensation and motion, it has been remarked that the bats become torpid between the temperatures of 50° and 44½° of Fahrenheit; the hedgehog about 44½°; the fat dormouse at 41°. The marmot and hamster cannot become torpid except at a temperature considerably below the freezing point; and they further require that their respiration should be impeded by diminishing, or altogether preventing, the accession of fresh air in the boxes or holes where they are confined.

Absolute torpidity can only be said to belong to these animals when their temperature has been fully reduced, and their respiration diminished, so that they at length come to be wholly deprived of sensation and voluntary motion. Hybernation is, however, susceptible of different degrees, which are characterised by the number of inspirations made in a given time; the absence of all respiratory movements marks in this case the highest degree of torpidity. All the species do not partake of it in the same degree. The bats experience a very slight lethargy. On the other hand, the marmot undergoes the most profound torpidity. The pulsations of the heart and arteries become greatly enfeebled during torpidity. In the active state of the hamster, the heart makes 150 pulsations in a minute, while in its torpidity it beats only 15 times. Bats, during summer, have only 100 pulsations in a minute. When they begin to grow torpid they have only 60; and as their lethargy increases, the action of the heart is so feeble that only 14 beats have been distinctly counted, and these were at unequal intervals. Dormice breathe so rapidly when they are awake, that it is scarcely possible to count their pulse; but as soon as they begin to grow torpid, 88 pulsations may be counted in a minute, 31 when they are half torpid, and only 20, 19, or even 16, when their torpor is not so great as to render the action of the heart wholly imperceptible.—[Reeve's Essay on Torpidity.]

The results of the recent researches of Dr. Marshall Hall regarding the sensibility of hybernating animals are at variance with those of preceding observers. According to him, the slightest touch applied to one of the spines of the hedgehog immediately rouses it to draw a deep inspiration; the merest shake induces a few inspirations in the bat, and the slightest disturbance is felt, as appears from its effect in inducing motion in the animal. In fact, he considers the sensibility of these animals during hybernation to be in the same condition as in ordinary sleep. On the other hand, according to MM. Prunelle, Spallanzani, Mangilli, Legallois, and Edwards, the strongest stimuli, with the exception of heat, make no impression upon them. Marmots are not roused from their torpid state by an electric spark strong enough to give a smart sensation to the hand, and a shock from a Leyden phial excited them only for a short time, as Spallanzani relates in his experiments made upon them jointly with Volta. They are insensible to the pricking of the feet and nose, and remain motionless and apparently dead. Bats are insensible also to every kind of stimulus except heat, or to a stream of air blown upon them, which affects their sensations powerfully. Wounds have been inflicted, and their limbs broken, without the mutilated animals exhibiting any external signs of pain. The internal temperature of these animals during their lethargic sleep chiefly depends upon that of the external air, yet it is usually from 5½° to 7° more elevated than the latter. Hence their temperature is very variable; it may descend to 37½° without changing the state of the animal; but the internal temperature cannot go below 32°, the freezing point of water, without either waking the animal or occasioning its death. There exists, therefore, a degree of external cold, which is incompatible with the torpidity or life of these animals. Species which most easily become torpid, such as the bats, hedgehog, and dormice, cannot support an external temperature of 14°, and a heat of 50° to 54° likewise awakens them. They may also be aroused by different mechanical means, such as by shaking them either gently or violently, according to the depth of their torpidity, without it being necessary at the same time to change the degree of external temperature. But if capable of resuming their activity in this way, they cannot long maintain it without the aid of a gentle heat. On being roused from their torpidity, they present all the phenomena of waking from ordinary sleep. When the torpid hedgehog is touched, it coils itself up more forcibly than before. The dormouse unfolds itself when similarly treated, and the bat moves variously. There is no stiffness nor lameness in their movements, and the bat even flies about with great activity, although exhaustion and death are the certain consequences. Dr. Marshall Hall thinks that those physiologists who assert the contrary have mistaken the phenomena of torpor from cold for a true hybernation.

From what has been said, it is evident that the repose of the hybernating mammalia is neither uniform nor constant in its duration. As it is influenced by the changes of the atmosphere, it may be continuous or interrupted according to the variations of the weather, or the precautions which the animals have taken to shelter themselves from the sudden changes of temperature, as well as their individual susceptibility. When these animals are very liable to be awakened, either from their constitution or habits, they instinctively take the precaution of amassing stores of provisions to supply their future wants. The hedgehog, for example, has been seen to form several separate stores, and to resort to them at different periods of the torpid season. Its traces have also been observed upon the snow. When torpid animals are suddenly and frequently awakened, their respiration becomes heightened, and death soon follows. "All those bats which were sent to me from distant parts of the country," says Dr. Marshall Hall, "died. The continual excitement from the motion of the coach keeping them in a state of respiration, the animal perished. One bat had, on its arrival, been roused so as to fly about. Being left quiet, it relapsed into a state of hybernation. The excitement being again repeated the next day, it again flew about the room; on the succeeding day it was found dead." We may thus see one reason of the precautions which these animals take to preserve themselves from being suddenly disturbed or excited. They select sheltered spots, such as burrows or deep caverns, at once secure from their enemies as from the inclemencies of the weather. The common bat (*Vespertilio murinus*) hangs itself by the claws of the hinder feet, with the head downwards, while the horse-shoe bat (*Rhinolophus ferrum-equinum*) spreads its wings to protect and embrace its companions. Many other animals form nests, and some congregate together. The hedgehog and dormouse roll themselves in a ball;—all which dispositions are evidently intended to preserve them from being disturbed by a low temperature.

There is no external character by which the hybernating animals can be distinguished from the others. Though some species belong to the same genus, such as the several dormice, yet this phenomenon is also found in the bats belonging to a family, separated by a wide interval, and comparative anatomists have sought in vain in the internal structure of these animals for an organization peculiar to them. It might, however, be expected, that their organization would approach to that which these animals possessed when in their embryo state; and this actually happens to a certain extent. A large quantity of fat is lodged in different parts of the body, but especially in the appendages of the peritoneum, which are always more numerous and extensive than in other species. The subrenal capsules, of whose use we are ignorant, but which we know are more developed in the fœtus than in the adult, are stronger and obtain some growth in these animals of which we are now treating. It is the same with the thymus gland and its appendages; that is to say, those granulous organs which are found to surround the necks of the torpid animals, such as the marmots, dormice, and bats, and may even extend between both shoulders, as in the bat, according to the observations of M. Jacobson of Copenhagen. These are nearly all the peculiarities yet observed in the hybernating animals, and they are very far from explaining the causes of this singular phenomenon.

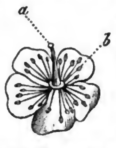
Hybernating animals are not found in all orders of the mammalia. None of the Quadrumana become torpid, probably because none of them are designed to inhabit a cold climate. The order of carnassiers, on the contrary, contains several, especially among such as reside in cold countries; several are also found among the rodentia, but the remaining orders do not contain any torpid animals.

We cannot by any means agree with M. Edwards in thinking that no species of animal is condemned by its nature to hybernate, and that the state of hybernation depends upon external circumstances, so that we can make it come and go by regulating the conditions under which animals are placed. On the contrary, we find that the nearer hybernating animals are permitted to approach to their natural mode of life in a domesticated state, the more they are disposed to follow their natural habits. Thus, torpidity seems perfectly congenial to the nature of the marmot, and if any animal can be said to be naturally torpid it is this. Although it can live during the whole winter without becoming torpid, it by no means follows from this that its tendency to become torpid is artificial. We could no more compel other animals to become torpid on the approach of winter, to whom such a state was unnatural, than we could assign to ourselves a new organ of perception. The circumstance that we have not yet succeeded in referring the phenomena of hybernation to any cause more general than itself, only proves that the ultimate cause is complicated and obscure, but ought not to lead us to doubt of its existence. In the preceding observations, reference has been made to those species only of whose hybernation there can be no doubt. Some species of bears and badgers, however, undergo a kind of lethargic sleep, termed *quiescence*. This state differs materially from that of ordinary hybernation, as the females bring forth their young during their interval of retirement. The common bear (*Ursus arctos*) is always loaded with fat in the autumn, when he retires to a den previously lined with branches and soft moss. Here he sleeps but little if the winter should be mild, and licks his fore-paws and soles of the feet continually during the intervals of repose; but when the winter is severe, he sleeps much. This state of quiescence cannot be studied with the same facility as that of hybernation, as these animals never become quiescent when in confinement, but remain as much awake during the winter as in the spring and summer. Some writers maintain that the number of animals susceptible of hybernation is very great; others are inclined to extend this supposition to all, even to man himself. Thus, Addison mentions an Englishman who underwent a lethargic sleep from the 5th to the 11th of August annually. Sheep in Iceland have been known to live under the snow; and instances often occur in Cumberland, Westmoreland, and the Highlands of Scotland, of sheep existing for four or five weeks under drifts of snow, where they can procure little or no food, and must, it is supposed, have become torpid. Persons have been known to continue asleep from seven to fourteen days, and some much longer, apparently from the influence of fear, anxiety, or other causes which tend to weaken the vital powers. Yet these and other instances are far from establishing the fact of torpidity, when we are unable to induce that state in any of these animals, under circumstances which would be certain to bring it on in those predisposed to hybernate. Had man not been exempt from that unknown law of Nature which compels certain of the lower animals to become torpid, we should find it exemplified in all those cases where men have been exposed to cold, and no allusion to such a fact is made in the history of the human species. Yet Gmelin measured a natural cold of 120° below zero, at Jenislisk, lat. 58° N., long. 110° E., in the year 1735; and Pallas, in 1772, found the temperature at Krasnajorsk, lat. 56° N., and 110° E., to be 80° below zero, so that a mass of quicksilver exposed to the air was frozen and became malleable. The Greenlanders go about with very light clothing, and the Norwegian peasants work during the winter with their bosoms bare, or roll themselves in the snow.

It would appear that there are certain animals which experience a corresponding state, that cannot properly be termed hybernation, as it happens during the hottest months of summer, and in tropical climates. The tenrecs, or Madagascar hedgehogs (*Centenes ecaudatus*), are asserted by Bruguière to undergo this summer torpidity or æstivation, but his statement has more recently been called in question by Mr. Telfair, in an account of that animal. Humboldt, however, has observed this remarkable state in the hottest parts of South America, in certain reptiles which pass a part of the year buried in the earth, and do not leave their state of torpor until the rainy season drives them from their retreats. The singular state of torpidity, induced by the excitement of a high temperature, may be considered as analogous to that daily sleep of man and the lower animals during the hottest parts of the day, and called the *siesta* in Spain and Italy. Neither cold nor heat can thus be said to be the cause of hybernation and æstivation, although they are auxiliaries to those states. In the same manner as it is neither cold nor heat that compels us to sleep every night, but a constitutional fatigue, and the necessity of repairing our forces; so in these annual sleeps the absence and presence of heat are merely proximate causes. Nature has wisely constituted these animals thus; for it is probable that their feeble constitutions would have otherwise failed to resist the cold, or they would perhaps have been unable to procure an adequate supply of food. When the period of torpidity is over, the rutting season usually commences, and these animals then enter anew upon the functions of life with renovated faculties.

HYBRID. The offspring of two plants of different species. A hybrid in the vegetable kingdom corresponds to a mule in the animal kingdom. See the next article.

HYBRIDIZING OF PLANTS. In the blossoms of fruit trees, and of most other plants, the seed is the offspring of the *stamens* and *pistil*, which may be considered the male and female parents, growing in the same flower. Cross-breeding is, then, nothing more than removing out of the blossom of a fruit tree the stamens, or male parents, and bringing those of another and different variety of fruit, and dusting the pistil or female parent with them,—a process sufficiently simple, but which has the most marked effect on the seeds produced. It is only within about fifty years that cross-breeding has been practised; but Lord Bacon, whose great mind seems to have had glimpses into every dark corner of human knowledge, finely foreshadowed it. "The compounding or mixture of plants is not found out, which, if it were, is more at command than that of living creatures; wherefore, it were one of the most notable discoveries touching plants to find it out, for so you may have great varieties of fruits and flowers yet unknown."



In the annexed figure, is shown the blossom of the cherry. The central portion, *a*, connected directly with the young fruit, is the *pistil*. The numerous surrounding threads *b*, are the *stamens*. The summit of the stamen is called the *anther*, and secretes the powdery substance called *pollen*. The *pistil* has at its base the embryo fruit, and at its summit the *stigma*. The use of the stamens is to fertilize the young seed contained at the base of the pistil; and if we fertilize the pistil of one variety of fruit by the pollen of another, we shall obtain a new variety partaking intermediately of the qualities of both parents. Thus, among fruits owing their origin directly to cross-breeding, Coe's Golden Drop Plum was raised from the Green Gage, impregnated by the Magnum Bonum, or Egg plum; and the Elton cherry, from the Bigarrieu, impregated by the White Heart. Mr. Knight was of opinion that the habits of the new variety would always be found to partake most strongly of the constitution and habits of the female parent. Subsequent experience does not fully confirm this, and it would appear that the parent whose character is most *permanent*, impresses its form most forcibly on the offspring.

The process of obtaining cross-bred seeds of fruit trees is very easily performed. It is only necessary when the tree blooms which we intend to be the mother of the improved race, to select a blossom or blossoms growing upon it not yet fully expanded. With a pair of scissors, we cut out and remove all the anthers. The next day, or as soon as the blossom is quite expanded, we collect with a camel's hair brush, the pollen from a fully blown flower of the variety we intend for the male parent, applying the pollen and leaving it upon the stigma or point of the pistil. If your trees are much exposed to those busy little meddlers, the bees, it is well to cover the blossoms with a loose bag of thin gauze, or they will perhaps get beforehand with you in your experiments in cross-breeding. Watch the blossoms closely as they open, and bear in mind that the two essential points in the operation are; 1st, to extract the anthers carefully, before they have matured sufficiently to fertilize the pistil; and, 2d, to apply the pollen when it is in perfection, (dry and powdery,) and while the stigma is moist. A very little practice will enable the amateur to judge of these points.

There are certain limits to the power of crossing plants. What is strictly called a *cross-bred* plant or fruit is a subvariety raised between two varieties of the same species. There are, however, certain species, *nearly allied*, which are capable of fertilizing each other. The offspring in this case is called a *hybrid*, or mule, and does not always produce perfect seeds. "This power of hybridizing," says Dr. Lindley, "appears to be much more common in plants than in animals. It is, however, in general only between nearly allied species that this intercourse can take place; those which are widely different in structure and constitution not being capable of any artificial union. Thus the different species of strawberry, of the gourd or melon family, intermix with the greatest facility, there being a great accordance between them in general structure and constitution. But no one has ever succeeded in compelling the pear to fertilize the apple, nor the gooseberry the currant. And as species that are very dissimilar appear to have some natural impediment which prevents their reciprocal fertilization, so does this obstacle, of whatever nature it may be, present an insuperable bar to the intercourse of the different genera. All the stories that are current as to the intermixture of oranges and pomegranates, of roses and black currants, and the like, may therefore be set down to pure invention."

In practice, this power of improving varieties by crossing is very largely resorted to by gardeners at the present day. Not only in fruit trees, but in ornamental trees, shrubs, and plants, and especially in florists' flowers, it has been carried to a great extent. The great number of new and beautiful roses, azaleas, camellias, fuchsias, dahlias, and other flowering plants so splendid in colour, and perfect in form, owe their origin to careful cross-breeding. In the amelioration of fruits it is by far the most certain and satisfactory process yet discovered. Its results are more speedily obtained, and correspond much more closely to our aim, than those procured by successive reproduction.

In order to obtain a new variety of a certain character, it is only necessary to select two parents of well known habits, and which are both varieties of the same, or nearly allied species, and cross them for a new and intermediate variety. Thus, if we have a very early, but insipid, and worthless sort of pear, and desire to raise from it a variety both early and of fine flavour, we should fertilize some of its pistils, with the pollen of the best flavoured variety of a little later maturity. Among the seedlings produced, we should look for early pears of good quality, and at least for one or two varieties nearly or quite as early as the female parent, and as delicious as the male. If we have a very small, but highly flavoured pear, and wish for a larger pear with a somewhat similar flavour, we must fertilize the first with the pollen of a large and handsome sort. If we desire to impart the quality of lateness to a very choice plum, we must look out for a late variety, whether of a good or bad quality, as the mother, and cross it with our best flavoured sort. If we desire to impart hardiness to a tender fruit, we must undertake a cross between it and a much hardier sort; if we seek greater beauty of colour, or vigour of growth, we must insure these qualities by selecting one parent having such quality strongly marked.

As the seeds produced by cross fertilization are not found to produce precisely the same varieties, though they will nearly all partake of the mixed character of the parents, it follows that we shall be most successful in obtaining precisely all we hope for in the new race, in proportion to the number of our cross-bred seedlings; some of which may be inferior, as well as some superior to the parents. It is always well, therefore, to cross several flowers at once on the same plant, when a single blossom does not produce a number of seeds.

We should observe here, that those who devote their time to raising new varieties, must bear in mind that it is not always by the first fruits of a seedling that it should be judged. Some of the finest varieties require a considerable age before their best qualities develop themselves, as it is only when the tree has arrived at some degree of maturity that its secretions, either for flower or fruit, are perfectly elaborated. The first fruit of the Black Eagle cherry, a fine cross-bred raised by Mr. Knight, was pronounced worthless when first exhibited to the London Horticultural Society; its quality now proves that the tree was not then of sufficient age to produce its fruit in perfection.—*Downing.*

HYDATID. An entozoon, or small animal existing parasitically within the interior organism of a larger animal. Hydatids occur in almost all parts of the world, and infest the brain, the liver, the spleen, and the spine of sheep, cattle, dogs, and swine. A hydatid in the spine is not common; and when it does occur, it occasions paralysis. Hydatids in the brain of sheep and cattle are comparatively frequent, and often give their name to the severe and peculiar disease which their presence causes.

The hydatid which infests the brain of sheep is called by naturalists *Hydatis polycephalus cerebralis*, or 'many-headed hydatid of the brain.' It has the appearance of a watery bladder, or of a translucent globular bag filled with water; and it may be either small or of the size of a hen's egg. Its coat comprises several layers,—one of which appears to possess some muscular power; its heads are irregularly distributed athwart the surface of the coat; a mouth, surrounded by minute sharp hooks within a ring of sucking discs, occurs on the front part of each head; and the several mouths, by means of their hooks and their sucking discs, effect the animal's parasitical or entozootical attachment. Numerous minute bodies adhere to the innermost layer of the coat; and the watery looking liquid which fills the interior is generally clear but sometimes turbid,—and, when in the latter condition, it contains a number of very small entozoons. The small bodies on the inner membrane seem to be rudimental or fœtal hydatids; the small entozoons in the liquid appear to be those fœtal bodies in an advanced stage toward maturity; and the bursting of the hydatids, with the consequent exit of the matured fœtal bodies from the brain, is probably the cause of the diffusion of hydatids among a flock,—the fœtal bodies falling upon the flock's food, and finding their way through the stomach or otherwise into the brain.

Hydatids occur sometimes singly in either the ventricles or at the surface of the brain, sometimes in twos or threes within the ventricles,—commonly on the top of one cerebral hemisphere, but occasionally within the substance of the cerebellum. If a hydatidized sheep move in a circle, he is supposed to be infested with only one hydatid, and to have this on the side toward which he moves, and probably in the ventricle. But "if the sheep sometimes make a circle in one direction and sometimes in another, we may conclude that there is a hydatid in each hemisphere, and when the animal depresses the head and moves straight forward, stumbling against everything in the way, it is probable that the hydatid is about the middle or division of the brain, and if the sheep throws up its head, has a reeling motion, but yet moves onwards, it is supposed that the hydatid is in the cerebellum or the fourth ventricle." [Spooner on Sheep.] A softness in the skull is discernible when the hydatid lies at the surface of the brain, but not when it lies in the ventricles. Either when a large hydatid has had a prolonged lodgment, or when several hydatids lie lodged together, very great devastations may, in various ways, be made upon the brain,—either one of the cerebral lobes may be almost totally destroyed, or one of the ventricles may be enormously distended, or one of the parietal bones may become so excessively absorbed as to offer astonishingly little resistance to the touch.

The disease caused by the presence of the hydatid in the brain of sheep is popularly called turn, turnsick, gig, goggles, staggers, sturdy, sturdy-gig, blob-whirl, and giddiness. Some persons think that a constitutional predisposition to it exists in cases of such a defective form of head as does not allow due space for the normal expansion of the brain; others think that an induced predisposition to it is created by bad feeding, by the influence of wet pastures, or by the effects of consanguineous breeding; and all, or very nearly all, are agreed that liability to it exists chiefly among sheep of less than 12 or 15 months old, and diminishes during the second year of sheep's age, and either wholly or mainly ceases after the close of the second year. It is supposed to destroy nearly a million of sheep every year in England; but it prevails much more extensively in France and other Continental countries than in Britain; and it cuts off about one sheep in every fifty in Germany.

A hydatidized sheep has a wandering, unsteady, staggering gait, and a dull, low-spirited, and insane appearance. He carries his head on one side, and in consequence has difficulty in feeding. He appears absent-minded, and sometimes stops and falls, and at other times runs careeringly across the field; and after he has been for a considerable time ill, he almost always moves circuitously or nearly in a circle. He has none of the ferocity or excessive wildness which accompanies other cerebral complaints; but suffers a heavy languor, is mopingly delirious, and eventually pines and sinks into coma or convulsions. All sheep affected with hydatids do not exhibit the whole of these symptoms,—or at least do not exhibit them in a prominent or very noticeable degree; yet each exhibits quite enough to enable any ordinarily skilful observer to see at once what is wrong.

Any medicinal appliance for the reduction and removal of hydatids in the brain is utterly useless. The brain is too destitute of absorbent vessels to take up a sufficiency of any medicinal substance for producing any sensible effect; and the substance of the hydatid is so strongly enclosed within the layers of the entozoon's coat as to defy the action of the most powerful substance which, with any safety, could possibly be introduced into the brain. The only known means of cure, and perhaps the only possible ones, are such methods of violence as mechanically rupture the hydatid; and most of these are both exceedingly cruel in the application, and imminently precarious in the result. Some of the coarsest and most common, suggesting themselves to many a farmer, and somewhat recommended by the great facility with which they can be practised, are to wring severely and then cut off the ears, to drive the sheep with violence and fury, to rally and worry and torture them with dogs, or to inflict some other tormenting and most exciting barbarity, with the view of rupturing the hydatid. But though, in some instances, these methods have had a considerable degree of success, they have, in other instances, immediately killed about twenty times more sheep than they have cured. Another method almost as rude and much more cruel, though appearing to be somewhat scientific, is to pass a wire or a knitting-needle or a trocbar up the nostril and through the perforated plate of the ethmoid bone into the brain. But if the instrument deviate, in even a very light degree from the proper path, it will be stopped by a projection of the frontal bone from above or by the solid portion of the ethmoid bone below, and will, in consequence, cause pain and perhaps provoke inflammation without the possibility of doing any good; if it be carried too low, it will injure the sensible portion of the brain, and cause the sheep either to die suddenly or to endure great agony; and even if it be most dexterously and quite faultlessly used, it will rupture only a hydatid situated directly in its way, and will not disturb one situated either on the surface or on one side, and will in any case occasion considerable tendency to inflammation. Mr. Hogg pretty confidently recommends this method; but very few intelligent and considerate persons will be disposed to try it. A much more scientific and successful method, called trepanning or trephining, is peculiarly suited to every case in which the precise situation of the hydatid is known or can with a very near approach to certainty be ascertained. "This is done by making two incisions so as to form when united the letter T over the somewhat softened part of the skull supposed to cover the hydatid. Turning the angles of the skin back, by dissecting them from the bone, the latter is now to be pierced by a trephine, and the portion of bone removed. This done, the brain will be exposed, and the hydatid, if at the part, will rise up covered by the *dura mater;* this must also be cut through and turned back, and the parasite punctured with a fine curved needle carrying a thread. As soon as it has shrunk up, it may be gently drawn away by means of the thread, and the *dura mater* and skin replaced over the part, the edges of the latter being held together by a stitch or two, and covered with a cap. The portion of the bone must not be returned." Mr. Smith of Southam repeatedly performed this operation with success; and Sir Astley Cooper performed it upon a sheep which he afterwards kept for many years. One of the easiest and simplest of the surgical methods, and perhaps also the most generally successful, is to feel for a soft part of the skull so as to ascertain with tolerable certainty the situation of the hydatid, to pierce the skull and its integuments at this part with a small awl so as to penetrate the hydatid, and to pump out the hydatidous liquid by means of a small syringe.

The prevention of tendency to the hydatid in flocks of sheep is of greatly more consequence than methods of cure. The tendency is not so great throughout Britain at present as at a former period; and as it seems to have been diminished simply by general improvement in stock-husbandry, so may it probably be annihilated merely by pushing that improvement to the utmost. The draining of pastures is one great measure, the promotion of a choice state of herbage is another, and great care in the judicious and suitable selection of breeding-stock is a third; and perhaps these three matters combined would, if properly and perseveringly attended to throughout any district, speedily put an end to the very existence of hydatids. The sheep-farmers in many parts of Continental Europe more or less protect their flocks from hydatids by the simple but inconvenient and comparatively expensive method of keeping all their sheep till after the completion of their first year within sheds or houses. An alleged means of both cure and prevention is recommended by Mr. Greaves of Bakewell in the Journal of the Royal Agricultural Society of England; and though it seems empirical, unmeaning, and altogether unpromising, it may be mentioned for the sake of any sanguine experimenter who may wish to try it. "The easiest and most effectual way," says Mr. Greaves, "not only to cure it, but to prevent its progress, is to take some common tar, and place it between the eyes of all the sheep, spreading it down to the nose; and it is astonishing to find how soon they recover; nor will any of the other sheep, having the tar applied in this manner, be liable to have the complaint."

Hydatids occur sometimes in young cattle, but less rarely than in sheep, and seldomer in Britain than on the Continent. They seldom if ever attack cattle of more than 18 or 20 months old; and they occur pretty often among young cattle in Switzerland. The symptoms are nearly the same as in sheep, but are, in many instances, liable to be mistaken for those of mere tumours in the brain, or of effusion of blood on the brain. When the symptoms are doubtful, treatment proper for the reduction of pressure on the brain, such as repeated bleeding, physicking, and spare diet, may be pursued, with considerable hope of success; but when the symptoms decidedly indicate the presence of hydatids, either trepanning or piercing with the awl may be practised as in the case of sheep, or—since the prospect of success is very small, and the operation must unavoidably inflict much torture—the beast may be immediately destroyed.—*Journal of the Royal Agricultural Society of England.—Quarterly Journal of Agriculture.—Mackenzie on Sheep.—Hogg's Shepherd's Guide.—Spooner on Sheep.—Youatt on Cattle.—Blaine's Veterinary Art.*

HYDNUM. A genus of fungi, of the hymeninous division,—the same division to which the agarics or mushrooms belong. About 20 species grow wild in Britain, and upwards of 70 species in other countries; and three of the indigenous species are esculent,—the rufescent, of a pinkish colour, inhabiting beech woods,—the imbricated, of an umber colour, inhabiting pine woods,—and the repand or scaly, of a yellowish colour, inhabiting miscellaneous woods.

HYDRACID. An acid which contains hydrogen as one of its elements. Most of the salts which are formed by a hydracid and a metallic oxide are so constituted as to hold the hydrogen of their acid and the oxygen of their base in the exact proportions to constitute water; and they are liable to such a counter-play of affinities as brings their elements into new or altered combinations. The hydrochlorate of soda, for example, experiences such a behaviour of affinities when it is undergoing crystallization as converts it into chloride of sodium.

HYDRANGEA. A genus of hardy, deciduous, ornamental shrubs, of the saxifrage order.

The arborescent species, *H. arborescens*, is a native of Virginia, and was introduced about 110 years ago to Britain. It seldom attains a height of more than 3 or 4 feet; yet, with ordinary good treatment, in any suitable situation, it is easily coaxed up to the height of 6 or 8 feet. It forms itself into a regular head, and has a very bushy and compact outline, and presents a highly interesting and decorative appearance. But either it or any of the other species, is quite out of place as a common house plant, and has an aspect of excessive coarseness when potted in juxtaposition with a geranium or a fuschia, and makes incomparably the best figure on the corner of a lawn or in the border of a shrubbery. The root of the arborescent hydrangea is fibrous and spreading. The stems, or rather radical branches, are numerous, soft, pithy, and ligneous,—much more voluminous than lofty,—green and quadrangular when young, and of a fine brown colour when old. The leaves constitute, in the aggregate, a very rich and imposing body of foliage; they have a fine green colour on their upper surface, and are somewhat downy on their under surface; they are nearly heart-shaped, but end in an acute point, and are serrated on their edges; they stand on long footstalks, opposite to each other, on the branches; and on a dry soil, they may be not more than 2 inches in length, and scarcely 1½ inch in breadth,—while, on a rich moist soil, they may be nearly 4 inches in length and 2¾ inches in extreme breadth. The flowers are produced in very large corymbose bunches, and, when seen at the distance of a few feet or a few yards, have a singularly showy and grandly imposing appearance; they come out at the end of every branch, and bloom in July and August; and they have a whitish colour and an agreeable odour. This species, especially when growing in open moist ground, propagates itself so rapidly by means of its spreading roots, and of ramose stems which rise from them, that more young plants of it than are almost ever wanted may, at any time, be obtained without any aid from art; yet, when requisite, it may also be propagated by layering. A variety of it called the two-coloured, *H. a. discolor*, occurs in some collections; but its two-colouredness has reference, not to the flowers, but to the leaves.

The garden species, *Hydrangea hortensis*, called by some botanists, *Hortensia opuloides*, is a native of China, and was introduced about 60 years ago to Britain. It usually attains but about half the height of the arborescent species; yet is a main favourite with cultivators, both because it blooms from spring till mid-autumn, and because it possesses the extraordinary and very interesting property of varying the tint of its flowers with the chemical properties of the soil in which it grows. The normal colour of its flowers, or that which they possess in its natural or best-loved soil of peaty-loam, is pink; but the colour, when it grows in a compost of two-thirds of sandy loam and one-third of fresh sheep's dung, especially when it also receives waterings of an infusion of sheep's dung, is always blue; a pleasing variety of shades results from growing it in soil mixed with peat-ashes or pitch-pine ashes, and watering it with soap-suds; and exceedingly brilliant hues are obtained by growing it in a compost of one-half garden mould, one-fourth coarse sand, and one-fourth hotbed manure, and watering it with the solution of a table-spoonful of saltpetre and half a table-spoonful of oxide of iron in an ordinary pailful of water. This species is propagated from cuttings.

The snow-white species, *H. nivea*, was introduced about 60 years ago from Carolina. It is scarcely so tall as the arborescent species, but blooms about the same period. A smoothish-leaved variety of it, *H. n. glabella*, occurs in some collections.—The heart-leaved species, *H. cordata*, was introduced about 40 years ago from Carolina. It is considerably taller than the arborescent species, and blooms about the same period.—The oak-leaved species, *H. quercifolia*, was introduced about 44 years ago from Florida. It has a height of about 4 feet, blooms from June till September, and is propagated from cuttings.

HYDRATE. A salt, an earth, an acid, or any other compound substance containing a definite proportion of water in combination with its other principles. Chalk, for example, is hydrate of lime; the strongest vitriolic acid of commerce is hydrate of sulphuric acid; and all salts which contain water of crystallization are hydrates of their respective bodies.

HYDRAULICS,—from *udor*, water, and *aulos*, a pipe, referring to the movement of water in certain musical instruments used by the Greeks,—that branch of hydrodynamics which has for its object the investigation of the motions of liquids, the means by which they are produced, the laws by which they are regulated, and the force or effect which they exert against themselves or against solid bodies.

This subject naturally divides itself into three heads: 1. the effects which take place in the natural flowing of fluids through the various ducts or channels which convey them; 2. the artificial means of producing motion in fluids, and destroying their natural equilibrium by means of pumps and various hydraulic engines and machines; and 3. the force and power which may be derived from fluids in motion, whether that motion be produced naturally or artificially.

The particles of fluids are found to flow over or amongst each other with less friction than over solid substances; and as each particle is under the influence of gravitation, it follows that no quantity of homogeneous fluid can be in a state of rest, unless every part of its surface is on a level, that is, not a level plane, but so far convex as that every part of the surface may be equally distant from the centre of the earth. As the particles of all liquids gravitate, any vessel containing a liquid will be drawn towards the earth with a power equivalent to the weight it contains, and if the quantity of the fluid be doubled, tripled, &c., the gravitating influence will be doubled, tripled, &c. The pressure of fluids is, therefore, simply as their heights,—a circumstance of great importance in the construction of pumps and engines for raising water. As liquids gravitate independently, if a hole be made in the bottom of the vessel, the liquid will flow out, those particles directly over the hole being discharged first. Their motion causes a momentary vacuum, into which the particles tend to flow from all directions, and thus the whole mass of the water, and not merely the perpendicular column above the orifice, is set in motion. If the liquid falls perpendicularly, its descent will be accelerated in the same manner as that of falling solid bodies. When water flows in a current, as in rivers, it is in consequence of the inclination of the channel, and its motion is referrible to that of solids descending an inclined plane; but, from want of cohesion among its particles, the motions are more irregular than those of solids, and involve some difficult questions. The friction between a solid and the surface on which it moves can be accurately ascertained; but this is not the case with liquids, one part of which may be moving rapidly and another slowly, while another is stationary. This is observable in rivers and pipes, where the water in the centre moves with greater rapidity than at the sides, so that a pipe does not discharge as much water in a given time, in proportion to its magnitude, as theoretical calculation would lead us to suppose. As water, in descending, follows the same laws as other falling bodies, its motion will be accelerated; in rivers, therefore, the velocity and quantity discharged at different depths would be as the square roots of those depths, did not the friction against the bottom check the rapidity of the flow. The same law applies to the spouting of water through jets or adjutages. Thus, if a hole be made in the side of a vessel of water, the water at this orifice, which before was only pressed by the simple weight of the perpendicular column above it, will be pressed by the same force as if the water were a solid body descending from the surface to the orifice; that is, as the square root of the distance of those two points; and, in the same way, water issuing from any other orifices, will run in quantities and velocities proportionate to the square root of their depths below the surface. Now, the quantity of water spouting from any hole in a given time, must be as the velocity with which it flows; if, therefore, a hole A be four times as deep below the surface as a hole B, it follows that A will discharge twice as much water in a given time as B, because two is the square root of four. A hole in the centre of such a column of water, will project the water to the greatest horizontal distance (or range), which will be equal to twice the length of the column of which the orifice is the centre. In like manner, two jets of water, spouting from holes at equal distances above and below the central orifice, will be thrown equal horizontal distances. The path of the spouting liquid will always be a parabola, because it is impelled by two forces, the one horizontal, and the other (gravitation) perpendicular.

The second division of the subject, mentioned in the beginning of this article, is of the greatest practical utility, as embracing an account of the various pumps and machines which have been employed to raise water; and numerous as these may appear, it will be found that they may all be comprehended under four general heads: 1. Those machines in which water is lifted in vessels by the application of some mechanical force to them. The earlier hydraulic machines were constructed on this principle, which is the simplest; such are the Persian wheel, consisting of upright buckets attached to the rim of a wheel, moving in a reservoir of water; the buckets are filled at bottom, as they pass through the water, and emptied at top, so that the water is raised a height equal to the diameter of the wheel. The wheel may be turned by living power, or, if in running water, by fastening float-boards to the circumference. The Archimedian screw, the bucket-engine or chain-pump, and the rope-pump of Vera, are modifications of the same principle. 2. The next class of machines are those in which the water is raised by the pressure of the atmosphere, and comprises all those machines to which the name of *pump* is more particularly applied. See PUMP. These act entirely by removing the pressure of the atmosphere from the surface of the water, which may thus be raised to the height of about 32 feet. See ATMOSPHERE, AIR. Whenever it becomes necessary to raise water to greater heights, 3. the third class of machines, or those which act by compression on the water, either immediately or by the intervention of condensed air, are employed. All pumps of this description are called *forcing-pumps*. Although atmospheric pressure is not necessary in the construction of forcing-pumps, it is, in most cases, resorted to for raising the water, in the first place, into the body of the pump, where the forcing action takes place. In machines of this kind, the water may be raised to any height. 4. The fourth class of hydraulic machines for raising water, consists of such engines as act either by the weight of a portion of the water which they have to raise, or of any other water that can be used for such purpose, or by its centrifugal force, momentum, or other natural powers; and this class, therefore, includes some very beautiful and truly philosophical contrivances, too numerous for us to describe. The Hungarian machine, the centrifugal pump, and the water-ram, are among the number.

The third general division of the subject relates to the means by which motion and power may be obtained from liquids, and includes the general consideration of water-wheels and other contrivances for moving machinery. Motion is generally obtained from water, either by exposing obstacles to the action of its current, as in water-wheels, or by arresting its progress in moveable buckets, or receptacles which retain it during a part of its descent. Water-wheels have three denominations, depending on their particular construction, on the manner in which they are set or used, and on the manner in which the water is made to act upon them; but all water-wheels consist, in common, of a hollow cylinder or drum, revolving on a central axle or spindle, from which the power to be used is communicated while their exterior surface is covered with vanes, float-boards, or cavities, upon which the water is to act. The undershot wheel is the oldest construction of this kind; it is merely a wheel, furnished with a series of plane surfaces or floats projecting from its circumference, for the purpose of receiving the impulse of the water which is delivered under the wheel. As it acts chiefly by the momentum of the water, the positive weight of which is scarcely called into action, it is only proper to be used where there is a great supply of water always in motion. It is the cheapest of all water-wheels, and is more applicable to rivers in their natural state than any other form of the wheel; it is also useful in tide-currents, where the water sets in opposite directions at different times, because it receives the impulse equally well on either side of its floats. In the overshot wheel, the circumference is furnished with a series of cavities or buckets, into which the water is delivered from above. The buckets on one side, being erect, will be loaded with water, and the wheel will be thus set in motion; the mouths of the loaded buckets, being thus turned downwards by the revolution of the wheel, will be emptied, while the empty buckets are successively brought under the stream by the same motion, and filled. The breast-wheel differs from this in receiving the water a little below the level of the axle, and has floats instead of buckets. In these two wheels, the weight and motion of the water are used, as well as its momentum, and a much greater power is, therefore, produced with a less supply of water than is necessary for the undershot wheel. In order to permit these wheels to work with freedom, and to the greatest advantage, it is necessary that the *back* or *tail* water, as it is called, or that which is discharged from the bottom of the wheel, should have an uninterrupted passage off; for otherwise it accumulates, and forms a resistance to the float-boards. One of the simplest methods of removing it consists of forming two drains through the masonry, on each side of the water-wheel, so as to permit a portion of the upper water to flow down into the tail, in front of the wheel. The water thus brought down with great impetuosity, drives the tail-water before it, and forms a hollow place, in which the wheel works freely, even if the state of the water be such that it would otherwise form a tailing of from 12 to 18 inches. The drains may be closed whenever the water is scarce. Numerous other contrivances are in use, which our limits will not permit us to describe. In Barker's centrifugal mill, the water does not act, as in the contrivances above noticed, by its weight or momentum, but by its centrifugal force and the reaction that is produced by the flowing of the water on the point immediately behind the orifice of discharge. It consists of a revolving vertical tube, which receives the water at top, and at the bottom of which is a horizontal tube, extending on each side of it, and having apertures opening in opposite sides, near the ends. The water spouting from these apertures keeps up, by its reaction, a constant rotary motion.

HYDRIODATE. A chemical compound of hydriodic acid and either an alkali or an alkaline earth. Hydriodic acid is a chemical compound of hydrogen and iodine; and hydriodates are interesting or valuable mainly on account of the latter of these elements. See the article Iodine. Hydriodate of potash is an important form of exhibiting iodine in medicine, and has a place in the Dublin pharmacopœia; but though it both occurs natively and can easily be made artificially, it exists only in the state of solution, and is resolved by crystallization into water and the iodide of potassium. The medicinal uses of this hydriodate are the same as those of iodine.

HYDROCHARIS. See Frogbit.

HYDROCEPHALUS. See Water-in-the Head.

HYDROCHLOA. A genus of hardy grasses, of the glyceria tribe. It is a recently constituted genus, and comprises only three indigenous species and one exotic species; and its name hydrochloa signifies 'water-grass,' and alludes to the aquatic character of its best-known species, *Hydrochloa aquatica*, called by some botanists *Glyceria aquatica*, and by others *Poa aquatica*, and noticed in our article Glyceria.—The maritime or sea-side species, *Hydrochloa maritima*, also ranked by some botanists as a glyceria and by others as a poa, is a perennial-rooted weed of the salt marshes of Britain, usually about 12 or 14 inches high, and flowering in June and July.—The distant species, *Hydrochloa distans*, likewise ranked by some botanists as a glyceria, and by others as a poa, is a perennial-rooted weed of the pastures of Britain, usually about 20 inches high, and flowering in July and August.—The reedy species, *Hydrochloa arundinacea*, was introduced about 26 years ago from the Caucasian Mountains; it is perennial-rooted and thoroughly aquatic; and it usually attains a height of 6 or 7 feet, and flowers in July.

HYDROCOTYLE. See Pennywort.

HYDROCYANIC ACID. See Prussic Acid.

HYDROGEN, a simple non-metallic body, forming acids by its union with chlorine, iodine and bromine, and hence termed an *acidifiable* body, and producing water by its combination with oxygen, in allusion to which the name *hydrogen* has been applied.

The most simple state in which we can procure it is in that of a gas, i. e., in union with caloric, and possibly with electricity and light. To effect this, water is always employed; and one of the following arrangements is adopted: water in the state of vapour is passed over metallic iron heated to redness, by adjusting a retort, half filled with this fluid, to one extremity of an iron tube containing clean iron wire, and laid across a heated furnace, the other extremity having a bent tube connected with it and dipping under the shelf of a pneumatic cistern; the water in the retort is made to boil briskly, and the steam to come in contact with the heated iron; upon which hydrogen gas is copiously disengaged, and collected in the pneumatic apparatus. Or, slips of sheet zinc, iron filings or turnings, or small iron nails, are introduced into a small glass-bottle with a bent tube, or into a common retort, upon which sulphuric acid, diluted with five or six times its weight of water, is poured; effervesence ensues, and the escaping gas may be collected in the usual manner. One troy ounce (480 grains) of zinc gives 356 oz. measures = about 676 cubic inches; and 1 ounce of iron, 412 oz. measures = 782 cubic inches, of hydrogen gas. The hydrogen obtained in these processes is not absolutely pure. The gas evolved during the solution of iron is contaminated by a compound formed from hydrogen and the carbon contained in the iron. This compound, which is a volatile oil, is removed by transmitting the gas through alcohol. The gas obtained by means of zinc is more free from impurities; though the small proportion of sulphur and carbon still remaining in the zinc of commerce, gives rise to the same compound as in the former case, and also to a sulphuretted hydrogen. The impurities in this instance are removed by passing the gas through a solution of caustic potash.

Thus purified, hydrogen gas has neither taste nor odour; it is colourless, and the lightest of all ponderable matter known, its specific gravity being 0·068, that of the atmospheric air being 1·000, or about 14½ times lighter than common air. This remarkable levity allows it to ascend with the greatest readiness through all liquids and gases, and is the cause of its being employed to fill balloons; which, notwithstanding the weight of the materials of which they are constructed, are sufficiently light, compared with the atmosphere, to rise to very great elevations, or until they meet with a medium whose density is such as to render them stationary. Hydrogen gas is a powerful refractor of light, and has hitherto resisted all attempts to compress it into a liquid. It is sparingly absorbed by water, 100 cubic inches of that liquid dissolving about 1½ of the gas. It is incapable of supporting respiration; nor is it a supporter of combustion; for when a lighted taper is passed up into an inverted glass full of hydrogen gas, it is immediately extinguished. But its most characteristic property is that of its inflammability, though, like other combustibles, it requires the aid of a supporter for enabling its combustibles to take place. This is exemplified by bringing a lighted candle or taper to the mouth of a narrow jar, or wide-mouthed bottle, filled with the gas; it is immediately kindled, but only burns where it is in contact with the air, the combustion going on quietly in successive strata from the orifice to the bottom of the vessel. Mingled with oxygen gas, no action takes place so long as the compound remains cold; but, on the approach of a flame, the whole is kindled at the same instant; a flash of light passes through the mixture, followed by a violent explosion. The report is the loudest when the proportions observed in the mixture are two volumes of hydrogen and one of oxygen. The same phenomena take place, though less strikingly, when atmospheric air is substituted for oxygen gas; in the latter case, however, the proportions are two measures of hydrogen to five or six of air. And not only is hydrogen gas inflamed when in contact with air or oxygen gas by the contact of a burning taper, but by a solid body heated to redness, and by the electric spark. If a jet of hydrogen be delivered upon recently prepared spongy platinum, this metal very quickly becomes red-hot, and then sets fire to the gas. The electric spark ceases to cause detonation when the explosive mixture, formed of two measures of hydrogen to one of oxygen, is diluted with 12 times its volume of air, 14 of oxygen, or 9 of hydrogen, or when it is expanded to 16 times its bulk by diminished pressure. Sudden and violent compression, likewise, causes an explosion of the explosive mixture; apparently from the heat emitted during the operation; for an equal degree of condensation, slowly produced, has not the same effect. When the action of heat, the electric spark and spongy platinum no longer cause an explosion, a silent and gradual combination between the gases may still be occasioned by them. Oxygen and hydrogen gases unite slowly with one another when exposed to a temperature above the boiling point of mercury, and below that at which glass begins to appear luminous in the dark. An explosive mixture, diluted with air to too great a degree to explode by electricity, is made to unite silently by a succession of electric sparks. Spongy platinum causes them to unite slowly, though mixed with 100 times their bulk of oxygen gas. A very high temperature is excited by the combustion of hydrogen gas, especially when it is burned in oxygen gas, as in the compound blow-pipe of Dr. Hare.

Water is the sole product of the combustion of hydrogen—a fact first demonstrated by Cavendish, who burned oxygen and hydrogen gases in a dry glass vessel, and obtained a quantity of pure water exactly equal to that of the gases which had disappeared during the experiment. The synthetic proof of the composition of water is obtained also by detonating two measures of hydrogen, mixed with one of oxygen, in a tube, over the mercurial cistern; the whole is condensed into water. Lavoisier first exhibited the composition of water analytically, by passing a known quantity of watery vapour over metallic iron heated to redness in a glass tube. Hydrogen gas was disengaged; the metal in the tube was oxydized; and the weight of the hydrogen, added to the increase which the iron had experienced from combining with oxygen, exactly corresponded to the quantity of water which had been decomposed. Its composition by volume is very clearly shown by galvanism. On resolving water into its elements by this agent, and collecting them in separate vessels, two measures of hydrogen to one of oxygen are obtained; and, on the other hand, these gases, when inflamed by the electric spark, unite in the exact ratio of one to two, whatever may be their relative quantity in the mixture. Hence the composition of water, by weight and measure, is:—

	By weight.	By volume.
Oxygen,	8	1
Hydrogen,	1	2

The processes for procuring a supply of hydrogen, described at the commencement of the present article, will now be intelligible. The first is founded on the fact that iron, at a red heat, decomposes water, the oxygen of which unites with the metal, while the hydrogen gas is set free. That the hydrogen which is evolved when zinc or iron is put into dilute sulphuric acid, is derived from the water, is obvious from the consideration, that of the three substances, iron or zinc, sulphuric acid, and water, the last is the only one which contains hydrogen. The product of the operation, besides hydrogen, is the sulphate of the protoxide of iron, if iron is used, or of the oxide of zinc, when zinc is employed. Hydrogen, therefore, is one of the most abundant substances in nature. It forms, as has been stated, eight-ninths of water; besides, with carbon and oxygen, it enters into the composition of all vegetable substances; and, with oxygen, carbon and nitrogen, it forms a part of all animal substances. Large quantities of it, often united with more or less of carbon, are continually evolved into the atmosphere from the decomposition of vegetable and animal matters.

HYDROLAPATHUM. See Dock.

HYDROLEA. A small genus of small, beautiful, blue-flowered plants, nearly allied to the convolvulaceous and polemoniaceous orders, but distinguished from them by two-styled flowers and two-valved capsules, and constituting an order of their own under the name of hydroleaceæ. The thorny species is a greenhouse aquatic; and was introduced to Britain about 56 years ago from South America. Its root has a bitter taste, and somewhat purgative properties; its stem is usually about a foot high; and its flowers have a pale blue colour, and bloom in June and July. Another species, a small, herbaceous evergreen, has been introduced; and 4 or 5 additional species are known.

HYDROPELTIS. A curious, red-flowered, floating plant, forming the type of the natural order hydropeltideæ. This order comprises only two species,—each constituting a distinct genus; and it is very nearly allied to the water-lily order.

HYDROPHOBIA,—from *udor*, water, and *phobos*, fear,—a specific disease arising from the bite of a rabid animal. The animals most liable to be afflicted with madness are dogs; but cats, wolves, foxes, &c., are also subject to it.

The following description of the way in which rabies affects dogs, is from a communication in the 'Sporting Magazine,' September, 1825:—"The symptoms of rabies in the dog are the following, and are given nearly in the order in which they usually appear:—An earnest licking, or scratching, or rubbing, of some particular part; sullenness, and a disposition to hide from observation; considerable costiveness and occasional vomiting; an eager search for indigestible substances—as bits of thread, hair, straw, and dung; an occasional inclination to eat its own dung, and a general propensity to lap its own urine. The two last are perfectly characteristic. The dog becomes irritable; quarrels with his companions; eagerly hunts and worries the cat; mumbles the hand or foot of his master, or perhaps suddenly bites it, and then crouches and asks pardon. As the disease proceeds, the eyes become red; they have a peculiar bright and fierce expression; some degree of strabismus, or squinting, very early appears—not the protrusion of the *membrana nictitans*, or haw, over the eyes, which, in distemper, often gives the appearance of squinting, but an actual distortion of the eyes; the lid of one eye is evidently more contracted than that of the other; twitchings occur round that eye; they gradually spread over that cheek, and finally over the whole face. In the latter stage of the disease, that eye frequently assumes a dull green colour, and at length becomes a mass of ulceration. After the second day, the dog usually begins to lose a perfect control over the voluntary muscles. He catches at his food with an eager snap, as if uncertain whether he could seize it; and he often fails in the attempt. He either bolts his meat almost unchewed, or, in the attempt to chew it, suffers it to drop from his mouth. This want of power over the muscles of the jaw, tongue, and throat increases, until the lower jaw becomes dependent, the tongue protrudes from the mouth, and is of a dark and almost black colour. The animal is able, however, by a sudden convulsive effort, to close his jaws, and to inflict a severe bite. The dog is in incessant action; he scrapes his bed together, disposes it under him in various forms, shifts his posture every instant, starts up, and eagerly gazes at some real or imaginary object; a peculiar kind of delirium comes on; he traces the fancied path of some imaginary object floating around him; he fixes his gaze intently on some spot in the wall or partition, and suddenly plunges and snaps at it; his eyes then close, and his head droops, but the next moment he starts again to renewed activity; he is in an instant recalled from this delirium by the voice of his master, and listens attentively to his commands; but as soon as his master ceases to address him, he relapses into his former mental wandering. His thirst is excessive (there is no hydrophobia, or fear of water, in the dog), and, the power over the muscles concerned in deglutition being impaired, he plunges his face into the water up to the very eyes, and assiduously, but ineffectually, attempts to lap. (In Johnson's Shooter's Companion, the author observes, 'In those instances of hydrophobia which have fallen under my notice, the animal has always been capable of lapping; however, in the disease called *dumb madness*, I have noticed symptoms similar to the above.') His desire to do mischief depends much on his previous disposition and habits. I have known it not to proceed beyond an occasional snap, and then only when the animal was purposely irritated; but with the fighting dog, the scene is often terrific. He springs to the end of his chain; he darts with ferocity at some object which he conceives to be within his reach; he diligently tears to pieces everything about him; the carpet or rug is shaken with savage violence; the door or partition is gnawed asunder; and so eager is he in this work of demolition, and so regardless of bodily pain, that he not unfrequently breaks one or all of his tushes. If he effects his escape, he wanders about, sometimes merely attacking those dogs which fall in his way; and at other times he diligently and perseveringly hunts out his prey: he overcomes every obstacle to effect his purpose; and, unless he has been stopped in his march of death, he returns in about four and twenty hours, completely exhausted, to the habitation of his master. He frequently utters a short and peculiar howl, which, if once heard, can rarely be forgotten; or if he barks, it is with a short, hoarse, inward sound, altogether dissimilar from his usual tone. In the latter stages of the disease, a viscid saliva flows from his mouth, with which the surface of the water that may be placed before him, is covered in a few minutes; and his breathing is attended with a harsh, grating sound, as if impeded by the accumulation of phlegm in the respiratory passages. The loss of power over the voluntary muscles extends, after the third day, throughout his whole frame, and is particularly evident in the loins: he staggers in his gait; there is an uncertainty in all his motions; and he frequently falls, not only when he attempts to walk, but when he stands, balancing himself as well as he can. On the fourth or fifth day of the disease, he dies, sometimes in convulsions, but more frequently without a struggle. After death, there will invariably be found more or less inflammation of the mucous coat of the stomach; sometimes confined to the rugæ, at other times in patches, generally with spots of extravasated blood, and occasionally intense, and occupying the whole of that viscus. The stomach will likewise contain some portion of indigestible matter (hair, straw, dung), and occasionally it will be completely filled and distended by an incongruous mass. The lungs will usually present appearances of inflammation, more intense in one, and generally the left lung, than in the other. Some particular points and patches will be of a deep colour, while the neighbouring portions are unaffected. The sublingual and parotid glands will be invariably enlarged, and there will also be a certain portion of inflammation, sometimes intense, and at other times assuming only a faint blush, on the edge of the epiglottis, or on the rima glottidis, or in the angle of the larynx at the back of it."

The hydrophobia seems to be spontaneous, and capable of being communicated only in certain animals—the dog, the wolf, the fox and the cat. All animals which have become rabid by a bite, do not appear to be able to transmit it to others; as the hog, cow, sheep. In regard to man, it is not certain whether the disease is communicable from the human subject. The hydrophobia is not commonly manifested in the time of the greatest cold or greatest heat, but usually in March and April in wolves, and in May and September in dogs. It is rare in very warm or very cold climates. No particular cause of the rabies is known; it is a mistake to attribute it to a total privation of food, as a great number of experiments prove that this is not the effect of such a treatment. All observations seem to prove the existence of a rabid virus, which is more violent when it proceeds from wolves than from dogs; as out of a given number of persons bitten by a rabid wolf, a greater number will die than out of the same number bitten by a dog. The communication of the virulent hydrophobia by inoculation cannot be denied, and is the best proof of the existence of the virus. The virus appears to be contained solely in the saliva, and does not produce any effect upon the healthy skin. But if the skin is deprived of the epidermis, or if the virus is applied to a wound, the inoculation will take effect. The development of the rabid symptoms is rarely immediate; it seldom takes place before the 40th or after the 60th day. It begins with a slight pain in the scar of the bite, sometimes attended with a chill; the pain extends and reaches the base of the breast, if the bite was on the lower limbs, or the throat, if on the upper extremities. The patient becomes silent; frightful dreams disturb his sleep; the eyes become brilliant; pains in the neck and throat ensue. These symptoms precede the rabid symptoms two or three days. They are followed by a general shuddering at the approach of any liquid or smooth body, attended with a sensation of oppression, deep sighs, and convulsive starts, in which the muscular strength is much increased. After the rabid fit the patient is able to drink. The disposition to bite does not appear to belong to any animals except those whose teeth are weapons of offence; thus rabid sheep butt furiously. A foamy, viscid slaver is discharged from the mouth; the deglutition of solid matters is difficult; the respiration hard; the skin warm, burning, and afterwards covered with sweat; the pulse strong; the fit is often followed by a syncope; the fits return at first every few hours, then at shorter intervals, and death takes place generally on the second or third day. A great number of applications have been recommended, but without success. The treatment of the disease is of two sorts; the one consists in preventing its development; the other in checking its progress. The former consists in cauterizing the wound with iron heated to a white heat, the pain of the cautery being less, as the temperature is greater. The cautery is preferable to the use of lotions, liniments, &c., but it should be employed within twelve hours after the bite. It has been said that, in patients who were about to become rabid, several little pustules filled with a serous matter appeared under the tongue, the opening of which would prevent the disease; but this is not well established. Various remedies have been prescribed for the cure of a declared hydrophobia. Bleeding, even to syncope, appears to have produced the greatest effect, but without complete success. Preparations of opium administered internally or by injection, mercurial frictions, belladonna, emetics, sudorifics, purgatives, &c., have been tried ineffectually. Yet the physician should not despair, as a remedy which has failed in one case may succeed in another. Above all, the patient should be treated gently, and his sufferings alleviated by consulting his comfort as much as possible; and the attendants should not forget, that there is no instance of the rabies having been communicated from one man to another.

The following is a condensed account of some important observations made by Dr. Wagner on the diseases commmonly called Rabies or Madness in domestic animals.

1. *The Dog.*—Dread of water is not always present, nor is the habit of gnawing wood, straw, or hides, or snapping in the air, a sure symptom. An appearance of dejection and shyness, drooping of the head and tail, flashing of the eye, foaming at the mouth, refusal of food and drink, are suspicious, but not peculiar to the disease. The only decisive

indication of it is a dog's running about and recklessly attacking men and animals, especially those of its own species. In a rabid state, some dogs will even leap over high fences, in order to reach dogs and cats which they discover to be on the other side, thus showing that smell, sight, and hearing, are still unimpaired. Others will sneak along a wall, or run forward in a straight line, attempting to bite whatever they meet with. Some again never move from one spot, but gnaw at every thing within reach, snap at vacancy, and ultimately refuse food and drink, or if they attempt to partake of either, appearing incapable of deglutition. In such cases, paralysis of the loins and posterior extremities appears to have taken place at the outset. The moment a dog evinces any appearance of illness, it ought to be locked up, or fastened to a strong chain. When it begins to gnaw wood, or show a dull eye, or snap at animals, to bark hoarsely, to attempt to run away or break its chain, to eat and drink in a snapping manner, to appear alternately lively and sulky, to disregard its master's call, to growl and snarl at well known persons, it ought to be killed, for no doubt can remain of its being rabid.

2. *In Oxen.*—The disease occurs in horned cattle in two distinct forms. In the first, the animal loses its appetite, eats and drinks by fits only, appears at times as if suddenly stupified, recedes from the manger, forgets to chew, then chews on, listens keenly to any noise, notices every object, but continues to obey its keeper. Borborygmi, however, are heard, and sometimes there is slight straining or disposition to tenesmus. In the open air, the animal ceases to graze, seems as if lost, and strays from the herd, but generally allows itself to be led back. The symptoms increase: hunger and thirst are not experienced, the eyes flash at times, without seeming inflamed, the animal seldom lows, but when it does, either emits a hoarse noise or a clear and strong cry. The borborygmi increase, the animal licks some parts of its body, especially one of the feet, where probably it has been bitten, until it is excoriated and bleeds. Paralysis of the loins ensues, the animal remains lying, can only rise with great difficulty, and totters on its hind-legs; an increased straining is remarked, and is followed by hard but ultimately thin evacuations; it moves its head from side to side, licks at cloth or fur, which it by degrees gets between its teeth and tears. The secretion of milk, which has been diminishing, now ceases. On the sixth or seventh day, the animal is unable to stand, refuses food, being unable to swallow; the straining at the rectum continues; but a dread of water is never observed. Sometime between the sixth and ninth day, it sinks on one side, commonly the left, the head stretched backwards, but the eye still lively and uninflamed. The trunk continues motionless, but the legs are languidly agitated, until the animal dies. In this form of the disease there is little danger in approaching the animal. The other form commences in the same manner. In the stall, the animals recede still more from the manger, and will try to break the rope with which they are fastened. Their bellowing is not frequent, but prolonged, and its tone clear; they scratch the ground with their fore-hoofs so violently as to throw the dung to the roof, and with their hind-feet kick at any one who approaches. The paroxysms are periodical, and in their intervals little is to be observed, except a reluctance to feed or drink. About the fourth day they will snap every kind of fastening during the paroxysm, attack and gore all who approach them, rage about in the stable, and gnaw the cribs and other objects, until paralysis of the limbs supervenes, when they fall, and ultimately lie on one side. On the seventh, eighth, or at most the ninth day, they die. On dissection, nothing unusual is to be discovered, excepting extreme distension of the gall-bladder.

3. *In Horses.*—The symptoms are at first unwonted activity, kicking and biting of their fellows, refusal of food and drink, frequent nodding or jerking of the head, and a fiery eye. On the second or third day the symptoms have greatly increased in degree, the animals become furious, and strive to bite and kick, so that it becomes necessary to destroy them.

4. *In Pigs.*—Only one instance occurred to the author. A fattening boar had been bitten by a mad dog four days previously to his seeing it, but it already raged with such violence that he could only observe it through the crevices of the sty. It gnashed its teeth, leaped against the sides of the sty, and threatened by its violence to burst through them. A butcher, who killed it with a hatchet, cut it up, contrary to orders, and exposed it to sale, but no mischief resulted.

5. *In Sheep.*—Five sheep, which were bitten by a mad dog, all became affected after the lapse of a few weeks, left off grazing, and dispersed the flock by indiscriminate attempts to butt and mount upon their fellows. They were all killed save one, which, being confined in a stall, kept quietly staring at the wall, but on hearing the slightest noise turned to the direction whence it proceeded, and jumped up against the sides of the stall. It neither ate nor drank, but the proprietor declined to wait the natural termination of the disease.

Country people frequently hold fast the tongue of the rabid cattle with one hand, while they thrust the other into the throat to endeavour to force nourishment into the stomach; yet, although the hands and arms could scarcely on all such occasions be entirely free from injury, and the people neglected to wash their hands, the author never witnessed any evil effects to result. However, he knew a farmer who died of rabies merely from having washed out the wound inflicted on a pig by the bite of a mad dog. He has frequently known the milk of rabid animals to be taken without detriment; and in two instances the flesh of rabid oxen, which was clandestinely eaten, proved innoxious. But, at a period when many cattle perished of rabies, the instances of canine madness became unusually numerous. He concludes with remarking, that having witnessed many instances where the bite of decidedly rabid animals has produced little or no effect upon the human subject, although the remedies employed were merely such as were suggested by superstition, he infers that in the human species a predisposition to hydrophobia rarely exists.

HYDROPHYLLUM. A small genus of herbaceous plants, constituting the type of the natural order hydrophylleæ or hydrophyllaceæ. This order consists of handsome, herbaceous, North American plants, with pinnately-parted leaves and pink or blue flowers; and comprises five genera; and has its station in the vicinity of the nightshade order.

The Canadian hydrophyllum, or Canadian water-leaf, *H. canadense*, is a native of Canada and many other parts of North America; and was introduced to Britain a little after the middle of last century. It naturally loves moist spongy ground. Its roots consist of many strong fleshy fibres, and spread widely on every side. Many leaves rise from the roots on footstalks of 5 or 6 inches in length, and are cut almost to the midrib, into from 3 to 7 indented and veined lobes, and have a lucid green colour; and, in spring, they preserve a lodgment of water in cavities on their border, and hence give rise to the popular name water-leaf, and the scientific one hydrophyllum. The floral footstalk rises from the root, and has one or two small leaves of similar shape to the large radical ones; and the flowers have a campanulate form, a dirty white colour, and an inconspicuous appearance, and grow in loose pendulous clusters, and bloom in May and June.—The Virginian species, *H. virginica*, was introduced about 20 years earlier than the preceding species, but is similar to it in appearance, habits, and period of bloom; but it has blue flowers, and ranks in its native country as an economical plant.

HYDROPIC ROT. See Rot.

HYDROPIPER. See Water-Pepper.

HYDROSULPHATE, or Hydrosulphuret. A chemical compound of sulphuretted hydrogen with either an alkali or an alkaline earth. Sulphuretted hydrogen is a chemical compound of hydrogen and sulphur; and is a gas and a weak acid. The compounds of it with the alkalies and alkaline earths are a kind of salts; but are readily decomposed by sulphuric, muriatic, acetic, and most other acids, with disengagement of their sulphuretted hydrogen, and the formation of sulphates, muriates, acetates, or other salts of their respective bases,—or by chlorine or iodine, with disengagement of their sulphur, and the formation of hydrochlorates or hydriodates.—The hydrosulphate or hydrosulphuret of ammonia is a valuable medicinal agent, and has a place in the pharmacopœias of Edinburgh and Dublin; it is a volatile fluid, and has been called the fuming liquor of Boyle; it has a green colour, a very fetid odour, and a disagreeable acrid taste; and it is administered in doses of 5 or 6 drops in a large tumbler of water, as a very powerful sedative upon the action both of the stomach and the arterial system. It is extensively used, also, as a reagent in processes of chemical analysis. The hydrosulphate or hydrosulphuret of potash exists in deliquescent hexagonal prismatic crystals; and has a bitter alkaline taste; and is used as a reagent.

HYDROSTATICS, — from *udor*, water, and *statike*, the science of bodies at rest,—is the science which treats of the weight, pressure, and equilibrium of liquid fluids.

The particles in liquids are freely moveable among each other, so as to yield to the least disturbing force; but though it was formerly believed that the liquid fluids are incompressible, recent experiments have shown that they may be indefinitely condensed by pressure. The fundamental truth, on which the whole science of hydrostatics rests, is equality of pressure. All the particles of fluids are so connected together, that they press equally in every direction, and are continually pressed upon; each particle presses equally on all the particles that surround it, and is equally pressed upon by them; it equally presses upon the solid bodies which it touches, and is equally pressed by those bodies. From this, and from their gravity, it follows, that when a fluid is at rest, and left to itself, all its parts rise or fall so as to settle at the same level, no part standing above or sinking below the rest. Hence, if we pour water or any other liquid into a tube bent like a U, it will stand at the same height in both limbs, whether they are of the same diameter or not, and thus a portion of the liquid, however small, will resist the pressure of a portion however large, and balance it. In a common tea-kettle, for instance, water poured into the body of the vessel will rise to the same level in the nose as in the vessel; and if poured into the nose, the same will also be true, and the small column of water in the nose balances the whole column in the body of the vessel, and will continue to do so, however large the one, and however small the other may be.

From this fact two important conclusions follow, derived both from reasoning and from daily experience. The one is, that water, though, when unconfined, it can never rise above its level at any point, and can never move upwards, will, on being confined in close channels, rise to the height from which it came, that is, as high as its source; and upon this principle depend all the useful contrivances for conveying water by pipes, in a way far more easy, cheap and effectual than by those vast buildings, called *aqueducts*, by which the ancients carried their supplies of water in artificial rivers over arches for many miles. In this case, the stream must have been running down all the way, and consequently a fountain fed from it at its termination, could not furnish the water at the same height as its source.

The other conclusion is not less true, but far more extraordinary, and, indeed, startling to belief, if we did not consider the reasoning upon which it is founded; it is that the pressure of the water upon any object against which it comes, is not in proportion to the body or bulk of the water, but only to the size of the surface, on or against which it presses, and its own height above that surface. Thus, in a tunnel-shaped vessel, the pressure on the bottom is not proportioned to the whole body of water in the vessel, but only to a column of the fluid equal in diameter to the bottom. The general rule for estimating the pressure of any fluid, is to multiply the height of the fluid by the extent of the surface on which it stands. If any portion of the fluid is supported by a tube above the remainder, the pressure on the bottom of the vessel will be the same as if the water was throughout at the same height as that in the tube, so that the height of the tube is properly multiplied by the extent of the bottom of the vessel, to determine the whole pressure. This principle of equal pressure has been called the *hydrostatic paradox*, though there is nothing in reality more paradoxical in it than that one pound at the long end of a lever should balance ten pounds at the short end; it is, indeed, but another means, like the contrivances called *mechanical powers*, of balancing different intensities of force by applying them to parts of an apparatus which move with different velocities. This law of pressure is rendered very striking in the experiment of bursting a strong cask by the action of a few ounces of water. Suppose a cask already filled with water, and let a long tube be screwed tightly into its top, which tube will contain only a few ounces of water; by filling this tube the cask will be burst. The explanation of the experiment is this: if the tube have an area of a fortieth of an inch, and contain half a pound of water, this will produce a pressure of half a pound upon every fortieth of an inch over all the interior of the cask. The same effect is produced in what is called the *hydrostatic bellows*. The tube is made to communicate with an apparatus constructed like a common bellows, but without a valve. If the tube holds an ounce of water, and has an area equal only to one thousandth of that of the top board of the bellows, an ounce of water in the tube will balance weights of a thousand ounces resting on the bellows. The hydrostatic or hydraulic press of Mr. Bramah is constructed on this principle; a prodigious force is thus obtained with great ease, and in a small compass, so that, with a machine the size of a common teapot, a bar of iron may be as easily cut as a slip of pasteboard. A small forcing pump takes the place of the tube in the instrument above described, and a pump barrel and piston is substituted for the bellows; water is then driven from the small pump into the large barrel under the piston, and the piston is thus pressed against the object to be operated upon. If the small pump have one thousandth of the area of the large barrel, and the force of 500 pounds be applied to its piston by its lever handle, the great piston will rise with a force equal to one thousand times 500 pounds, or more than two hundred tons. The uses to which this power may be applied, are of great variety and extent, but this branch of art seems to be yet in its infancy. Upon the tendency of all the parts of fluids to dispose themselves in a plain or level surface, depends the making of *levelling* instruments, or instruments for ascertaining whether any surface is level, or any line horizontal; for finding what point is on the same level with any given point, and how much any point is above or below the level of any other point.

We have thus far spoken of the pressure of liquids upon a horizontal or level surface, in which case it is only necessary to multiply the height of the fluid by the extent of the surface, and the weight of the bulk is equal to the pressure upon the surface. But if the surface is not horizontal, a different rule must be applied; for then the pressure is equal to the weight of the bulk, found by multiplying the extent of the surface into the depth of the centre of gravity of the surface. In this manner we can find the pressure upon a dam; we must take half the depth of the water, and multiply it by the superficial extent of the dam; this gives the bulk of water whose weight is the pressure on the dam. The pressure against the upright sides of a cylinder filled with water, may be found by multiplying the curve surface under water by the depth of its centre of gravity, which is half the depth of the water. The increase of pressure in proportion to the depth of the fluid, shows the necessity of making the sides of pipes or masonry, in which fluids are to be contained, stronger in proportion to their depth. It is therefore needless to make them equally thick and strong from the top downwards. If they are thick enough for the great pressure below, they will be thicker than is required for the smaller pressure above. The same is true in regard to flood-gates, dams and banks. When a solid body is plunged in any liquid, it must displace a quantity of that liquid exactly equal to its own bulk. Hence, by measuring the bulk of the liquid so displaced, we can ascertain precisely the bulk of the body; for the liquid can be put into any shape, as that of cubic feet or inches, by being poured into a vessel of that shape divided into equal parts. This is the easiest way of measuring the solid contents of irregular bodies. When a body is plunged into a liquid, if it be of the same weight as the liquid, it will remain in whatever part of the fluid it is placed; if it be heavier, it will sink to the bottom; if lighter, it will rise to the top. If any body, therefore, be weighed in the air, and then weighed in a liquid, it will lose as much in weight as an equal bulk of the liquid weighs. In this manner we determine the relative weights of all bodies, or the proportion which they bear to each other in weight, which is called their *specific gravity*. Suppose a mass of gold, for instance, to have a certain weight in the air; it would lose, on being weighed in water, about a 19th of its weight; that is, the gold would be 19 times heavier than water. The instrument used for this purpose is called the *hydrostatic balance*, and affords the easiest and most accurate method of comparing all substances, whether solid or fluid. This operation may be performed with substances lighter than water, by attaching them to a stiff pin, fastened to the bottom of the scale, or by suspending some heavy substance of a known weight. The same principle also enables us to ascertain the specific gravities of different fluids; for, if the same substance be weighed in two fluids, the weight which it loses in each is as the specific gravity of that fluid. If a drop of water, or any liquid of a like degree of fluidity, be pressed upon a solid surface, it will wet that surface and adhere to it, instead of preserve a lodgment of water in cavities on their border, and hence give rise to the popular name water-leaf, and the scientific one hydrophyllum. The floral footstalk rises from the root, and has one or two small leaves of similar shape to the large radical ones; and the flowers have a campanulate form, a dirty white colour, and an inconspicuous appearance, and grow in loose pendulous clusters, and bloom in May and June.—The Virginian species, *H. virginica,* was introduced about 20 years earlier than the preceding species, but is similar to it in appearance, habits, and period of bloom; but it has blue flowers, and ranks in its native country as an economical plant.

HYDROPIC ROT. See Rot.

HYDROPIPER. See Water-Pepper.

HYDROSULPHATE, or Hydrosulphuret. A chemical compound of sulphuretted hydrogen with either an alkali or an alkaline earth. Sulphuretted hydrogen is a chemical compound of hydrogen and sulphur; and is a gas and a weak acid. The compounds of it with the alkalies and alkaline earths are a kind of salts; but are readily decomposed by sulphuric, muriatic, acetic, and most other acids, with disengagement of their sulphuretted hydrogen, and the formation of sulphates, muriates, acetates, or other salts of their respective bases,—or by chlorine or iodine, with disengagement of their sulphur, and the formation of hydrochlorates or hydriodates.—The hydrosulphate or hydrosulphuret of ammonia is a valuable medicinal agent, and has a place in the pharmacopœias of Edinburgh and Dublin; it is a volatile fluid, and has been called the fuming liquor of Boyle; it has a green colour, a very fetid odour, and a disagreeable acrid taste; and it is administered in doses of 5 or 6 drops in a large tumbler of water, as a very powerful sedative upon the action both of the stomach and the arterial system. It is extensively used, also, as a reagent in processes of chemical analysis. The hydrosulphate or hydrosulphuret of potash exists in deliquescent hexagonal prismatic crystals; and has a bitter alkaline taste; and is used as a reagent.

HYDROSTATICS, — from *udor,* water, and *statike,* the science of bodies at rest,—is the science which treats of the weight, pressure, and equilibrium of liquid fluids.

The particles in liquids are freely moveable among each other, so as to yield to the least disturbing force; but though it was formerly believed that the liquid fluids are incompressible, recent experiments have shown that they may be indefinitely condensed by pressure. The fundamental truth, on which the whole science of hydrostatics rests, is equality of pressure. All the particles of fluids are so connected together, that they press equally in every direction, and are continually pressed upon; each particle presses equally on all the particles that surround it, and is equally pressed upon by them; it equally presses upon the solid bodies which it touches, and is equally pressed by those bodies. From this, and from their gravity, it follows, that when a fluid is at rest, and left to itself, all its parts rise or fall so as to settle at the same level, no part standing above or sinking below the rest. Hence, if we pour water or any other liquid into a tube bent like a U, it will stand at the same height in both limbs, whether they are of the same diameter or not, and thus a portion of the liquid, however small, will resist the pressure of a portion however large, and balance it. In a common tea-kettle, for instance, water poured into the body of the vessel will rise to the same level in the nose as in the vessel; and if poured into the nose, the same will also be true, and the small column of water in the nose balances the whole column in the body of the vessel, and will continue to do so, however large the one, and however small the other may be.

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To effect this, the dial is divided off into degrees, over which the index passes; when the air is dry, the wood contracts and pulls the index hand in one direction, when it is damp, it expands, and pushes it in the opposite. The greatest amount of atmospheric dryness forms one extreme of the scale, and that of wetness the other: between these two points the index is incessantly moving, as the state of the atmosphere varies. One of these instruments is so sensitive, that mere breathing upon it sets it in action; and it has the great merit of indicating at all times by its index hand exactly what the state of the air may be.

HYGROPHILA. A small genus of tropical plants, of the acanthaceous order. The gaping species, *Hygrophila ringens*, called by Linnæus, *Ruellia ringens*, is a small evergreen trailer; and was introduced to the botanical collections of Britain, about 27 years ago, from India. The juice of its leaves, boiled with a little salt, is used as a medicine on the Malabar coast, and is supposed to correct a morbid state of the fluid secretions. Its name hygrophila singifies 'love of moisture,' and alludes to the character of its natural habitat.

HYLESINUS. A genus of insects of the xylophagous or wood-eating family of beetles. The species of it are nearly allied to those of the hylurgus genus; but may be readily distinguished by the short ovate shape of their body, and by the three-jointedness of the club of their antennæ. Their tortuous paths through the timber on which they feed are always more insulated than those of the scolyti, and never so extensive. One of the most common species in Britain feeds on the ash, and has thence the name of *Hylesinus fraxini*. In varies in length from 1¾ line to upwards of 2 lines; it has a blackish-brown colour, and is covered with ash-coloured scales above, and variegated with dusky-coloured scales below; its antennæ are rusty-red; its club is dusky; its elytra are indistinctly punctate-striate; its underside is clothed with an ashy grey pubescence; its legs have a pitch colour; and its tarsi are reddish-yellow. It sometimes seriously injures the bark of ash-trees; but, except when other adverse circumstances are in operation, it seldom impairs the organic vigour of the trees, or even sensibly affects their health.

HYLOBIUS. A genus of insects, of the rhynchophorous or snouted family of beetles. The name hylobius is formed from two Greek words which signify "wood" and "life;" and alludes to the fact that the larvæ live in the interior of trees.

The fir-infesting species, *Hylobius abietis*, is one of the largest of the native weevils of Britain, and inflicts great injury on some of the plantations of Scotland. Its body is from half an inch to three-fourths of an inch in length; its general colour is obscure pitchy black; its head is roughly punctured with scattered yellow hairs, and is somewhat depressed between the eyes, and has on each side a tuft of ochreous yellow hairs; its rostrum is also roughly punctured with scattered yellow hairs, and has a narrow ridge down the middle; its antennæ are dark pitchy red; its thorax is deeply and somewhat longitudinally rugose-punctate, and has a faint dorsal ridge, and strong yellow hairs; its scutellum is clothed with an ashy-grey pubescence; its elytra have numerous small spots or patches of strong depressed yellow hairs, some of the spots irregularly distributed, and others forming two spotted cross lines; and its legs and the under part of its body have a pitchy black colour, and are punctured with thinly scattered rigid hairs. This insect is readily distinguishable from an allied fir-destroying species of *Pissodes* by the insertion of its antennæ near the apex of the rostrum, while the insertion of those of the Pissodes is behind the middle of the rostrum.

This insect abounds in Scotland, is less common in the north of England, and becomes somewhat rare in the south of England. It has been long known to naturalists to infest fir-trees, and was long supposed to do them little harm; but it has been found within the last twenty years, to perpetrate severe and very extensive mischief. It principally haunts old fir and pine plantations; and it breeds in the bark, or between the bark and the wood, or chief of all in the decaying stumps and roots of removed trees. Its ovules are generally deposited in August and September; its larvæ are soon hatched, and continue till July; its pupæ evolve from the larvæ in July; and the perfect insects appear in August. The perfect insects fly imperfectly and seldom; they often move about in the day-time, on the surface of the ground; and they are encased in so very strong a shield, that treading them among the grass does them no harm. The insects are dormant from about the middle of October till about the middle of April; and they make their chief attacks on trees at three seasons of the year,—first from their vernal awakening till the end of May, next in August when the young brood comes above ground, and next in the end of September just before they retire to their winter's sleep. They peel round a young tree, in the first and second years after its being planted, as completely as can be done by hares or rabbits; and they generally begin to peel near the root, so as very speedily to kill the tree. Mr. Balden, forester to Lord Blantyre, in giving in 1841 an account of their ravages, says, "In March 1830, after properly surface-draining a piece of ground containing between 6 and 7 acres, where an old fir wood was cut down two years previously, I replanted it with larch, spruce, Scotch firs, and oaks; of these trees 20,000 were larch, 7,000 spruce and Scotch firs, and 300 oaks; and by the end of June, there were not above 10 larch, spruce, and Scotch firs out of 1,000 that were not more or less barked, and the greater part completely killed. I have replanted the same ground over for six years, some parts of it almost new; and as we have been cutting down and replanting, more or less, for the last 12 years, I consider that in the course of that time, they have destroyed above 60,000 or 70,000 larch, besides spruce and Scotch firs, while at the same time they have left thousands of very stunted trees standing apparently half dead." Mr. Balden, previous to a clever detection of the real depredators, ascribed the barking and killing of the trees to mice and rabbits; and many foresters, who have witnessed similar depredations upon their coniferous plantations, have probably committed the same mistake. The hylobius is also very destructive to juniper and birch trees; and it seems to commit its main depredations during the night and the early part of the morning.

In places where the hylobius has found a lodgment, all stumps of old trees ought to be grubbed up,—ground intended for a plantation ought, if the circumstances of it will at all permit, to be either dug or trench-ploughed,—and young plants of larch, spruce, Scotch pine, juniper, birch, and similar trees, may, immediately before planting, be dipped in a mixture of one part of spirits of turpentine and five or six parts of lime water. When the insects have established themselves upon a young plantation, they may be destroyed either by washing the young trees with the mixture of turpentine and lime water, or by cautiously spreading a sheet on the ground beneath each tree, and then either shaking it or striking it smartly with a pole, and afterwards destroying the contents of the sheet. This latter operation owes its success to a curious instinct in the insects,—that, the moment the tree on which they are feeding is struck or shaken, they fall to the ground upon their back as if they were dead; and it requires to find them in the act of feeding, and must therefore be performed at a very early hour in the morning.

HYLURGUS. A genus of insects, of the xylophagous or wood-eating family of beetles. Its species have a considerable affinity both to those of the genus hylesinus, and to those of the genus scolytus; but they differ very perceptibly in form from the former, and in economy from the latter. Their antennæ are eleven-jointed and strongly clubbed, and have the first joint bent and very long, the second globular, the third smaller and obconic, the next four transverse, and the last four in the form of a globular pubescent club; their mandibles are acute and triangular, and their other oral organs small; their eyes are long and narrow; their body is rather long and cylindrical; their tibiæ are apically dilated, and externally bidentate; and their tarsi are five-jointed, and have the penultimate joint bilobed. Several species, all somewhat closely resembling one another, make devastations upon different kinds of timber-trees, and particularly upon pines; and two species, *H. ater* and *H. angustatus*, are very great devastators in some parts of Continental Europe; but one species, *H. piniperda*, is exceedingly pre-eminent, at once on account of its being the type of the whole genus, on account of its prevalence in Britain, and on account of the great extent of mischief which it perpetrates.

The *Hylurgus piniperda* is nearly two lines in length, and is punctured and slightly pubescent, and has generally a pitch black colour, but varies in shade down to a mere pale colour, and has occasionally reddish or chestnut-coloured elytra. Its head projects a good deal forward, and has a short longitudinal ridge in the middle of the front; its antennæ are ferruginous; its thorax is thickly set with rounded punctures; its elytra are cylindrical, roughly punctured, and somewhat wider than the thorax, and have each nine punctured striæ; its legs are pitch-coloured; and its tarsi are light reddish-yellow. It chiefly infests the Scotch pine; it also attacks the spruce; and either it, or some species which has been mistaken for it, has worked havoc upon the *Pinus ponderosa*, and some other foreign pines. It abounds in most young plantations of the Scotch pine, and occasions the serious injury or absolute loss of very many of the young trees. It resembles the scolyti in perforating the bark and wood of the trunk; but does most damage by making longitudinal bores through the terminal shoots,—burying itself horizontally into the lower part of twigs, linearly ascending their interior, and either laterally or terminally emerging at their top. "For the purpose of examining its proceedings," says Dr. Lindley, "I placed a shoot of the Scotch pine under a glass with the insect. In about three hours afterwards, it had just begun to pierce the bark at the base of one of the leaves. Its mandibles seemed chiefly employed, its legs being merely used as a means of fixing itself more firmly. Four hours after, its head and thorax were completely buried in the shoot; and it had thrown out a quantity of wood, which it had reduced to a powder, and which nearly covered the space within the glass. In sixteen hours more, it was entirely concealed, and was beginning to form its perpendicular excavations, and was busily employed in throwing back the wood as it proceeded in destroying it. There were evidently two kinds of this sawdust, part consisting of shapeless lumps, but the greater portion of very thin semitransparent lamellæ, or rather shavings. I now examined it every day till the fifth, when I found it had emerged through the central buds, at about one inch from where it had first entered."

HYMENÆA. See Locust-Tree.

HYMENANTHERA. An ornamental, evergreen, Australian shrub, of the violet order. It constitutes a genus of itself, and takes for its specific name *dentata* or the toothed-leaved. It has a one-seeded pericarp, and solitary pendulous seeds; and, in consequence, possesses some affinity to the polygala tribe. It was introduced to Britain about 27 years ago. It attains a height of 6 or 8 feet, and carries yellow flowers in April and May.

HYMENOCARPUS. A small genus of beautiful, yellow-flowered, hardy, Italian, annual plants of the lotus division of the leguminous order. Three species, the ray-podded, the round-podded, and the moneywort-leaved, belong to it, and were all formerly included in the genus medicago; and they closely resemble that genus in general character, but differ from it in having membranous fruit. The round-podded and the moneywort-leaved have a trailing habit. See the article Medick.

HYMENODICTYON. A small genus of ornamental, tropical, dendritic plants, of the madder family. The tall species, *H. excelsa*, called by some botanists *Cinchona excelsa*, is a native of India; and attains there a height of between 30 and 40 feet; and is an evergreen; and was introduced about 27 years ago to British collections. Dr. Roxburgh says that its bark possesses the bitterness and astringency of the Peruvian, and that, when fresh, it possesses these in even a stronger degree. Another species, *H, thyrsiflora*, about half the natural height of the preceding, has been brought to Britain from India.

HYMENOPAPPUS. A small genus of annual-rooted plants, of the sunflower division of the composite order. Three white-flowered, autumn-blooming species, of from 12 to 30 inches in height, have been introduced to Britain from North America; but they are more curious than beautiful.

HYMENOPHYLLUM. See Filmy-Leaf.

HYOSCYAMUS. A genus of plants, of the nightshade family. One species grows wild in Britain; and about half a dozen annual species, and as many perennial ones, have been introduced from other countries. Most have the appearance of mere weeds; but several possess an intense interest as medicinal and poisonous narcotics. *H. albus, aurens, physaloides*, and *scopolia*, are all deemed poisonous; and only *H. orientalis, physaloides*, and *auriculatus*, possess anything of an ornamental character.

The indigenous species, or henbane, common henbane, or black hyoscyamus, *H. niger*, concentrates in itself the main interest and terrors of the genus. It occurs somewhat frequently on rubbish, on waste grounds, and at the sides of roads, especially on calcareous soils. Its root is annual or biennial, long, compact, tapering, and fibrous; its stem is cylindrical, woody, branched, erect, and about three feet high; its leaves are alternate, sessile, large, deeply sinuated, woolly, and of a sea-green colour,—and the lower ones are upwards of a foot in length; and its flowers grow in terminal, simple, recurved spikes, and have a straw-colour, beautifully marked with retiform purple veins, and usually bloom in June and July.

The whole plant is clothed with soft white hairs, and has a clammy, sticky touch, and is strongly poisonous to man and some other animals. Hogs are intoxicated by it; and cows, horses, dogs, and goats can eat a considerable quantity of it without material injury; but all of these loathe it, poultry are killed by it, and man is affected by it in the same sort of way as by opium. It was regarded by our forefathers as having something to do with the producing of the old English leprosy; it is accused by some herbalists of causing gangrenous blotches; and it figures, in the ideal creations of Shakspeare, as the mysterious means of the murder of Hamlet's father. An overdose of it, or an accidental poisoning with it, produces sickness, stupor, dimness of sight, dilatation of the pupils, delirium, and coma; and must be combated first with an emetic, and next with doses of vinegar.

The fresh leaves have a strong, narcotic, and somewhat fetid odour, and a mucilaginous and slightly acrid taste; but the dried leaves are nearly odourless and insipid. The active principles of the plant are completely extracted by diluted alcohol; and comprise a peculiar alkaloid, gallic acid, resin, mucus, and ordinary extractive matter. The peculiar alkaloid has been called hyoscyamia, and appears to be the seat of the plant's narcotic and characteristic powers; and it occurs more plentifully in the seeds than in the roots or the leaves, and exists in the form of a malate, and crystallises in long prisms, and combines with acids to form neutral salts. The inspissated juice of the fresh leaves, and the tincture of the dried ones, are the ordinary medicinal preparations of hyoscyamus; and they first stimulate the pulse, and next diminish it and induce sleep; and are prescribed in cases where opium fails to act duly as a narcotic, and in cases of gout, rheumatism, spasms, hysteria, and mania. The seeds and capsules are sometimes smoked by the peasantry as a remedy for toothache; but they are a very perilous one, and may produce both convulsions and delirium. A solution of the extract in water has been successfully employed, in veterinary practice, as an external application for very irritable chronic inflammation of the eye.

HYOSERIS. See Swine's Succory.

HYPECOUM. A small genus of hardy, yellow-flowered, ornamental, annual plants, of the poppy order. Two trailing species, *H. procumbens* and *H. pendulum*, were introduced to Britain very long ago from the South of Europe; and an upright species, *H. erectum*, about 88 years ago, from Siberia. One of the former is described as follows by Miller:—"It hath many wing-pointed leaves of a greyish colour, which spread near the ground, and slender branching stalks, which prostrate on the ground; these are naked below, and at top are garnished with 2 or 3 small leaves of the same shape and colour with the under ones; from between these leaves come out the footstalks of the flower, each sustaining one yellow flower with 4 petals, and a pointal stretched out beyond the petals, which afterward turns to a jointed compressed pod about 3 inches long, which bends inward like a bow, having one roundish compressed seed in each joint."

HYPERANTHERA. See HORSE-RADISH-TREE.

HYPERICUM,—popularly *St. John's Wort.* A large and diversified genus of ornamental plants, constituting the type of the natural order Hypericineæ. Four or five stove species, about 40 greenhouse species, between 12 and 20 hardy ligneous species, and upwards of 40 hardy herbaceous species, at present in Britain, belong to this order; and these are distributed among 7 genera. They are somewhat akin to the plants of the orange and the guttiferous families. All have a large quantity of resinous juice; most are bitter and slightly astringent; and the majority are shade-loving and thicket-seeking herbs and undershrubs of the temperate latitudes of Europe and Asia. The leaves of all are dotted; the flowers of by far the greater number are yellow; and the juice of most is yellow, viscid, and bitterish, often purgative or anthelmintic, and sometimes exceedingly similar to gamboge.

The genus hypericum comprises about six-sevenths of all the species of the order in Britain, and possesses a corresponding proportion of its characteristic properties and its importance. Eleven indigenous species, and upwards of 70 exotic ones are in Great Britain and Ireland; and between 50 and 60 more are known. The flowers of many are very handsome, and combine with the foliage to render the plants exceedingly ornamental; those of almost all are more or less resiniferous; those of the majority have a strong disagreeable odour when bruised, and an astringent bitter taste; and those of some have long been used for medicinal, economical, or superstitious purposes. Two of the species in Britain are respectively an annual and a biennial, and require to be treated in the same manner as ordinary hardy garden annuals; a very large proportion are either hardy undershrubs or hardy perennial-rooted herbs, and require to be treated in the same manner as the ordinary hardy perennials of the flower-border and the shrubbery; and about a dozen are greenhouse evergreen undershrubs, and thrive best in a mixture of loam and peat, and are readily propagated by striking young cuttings under a glass.

The common or perforated St. John's wort, *Hypericum perforatum,* is a perennial-rooted, indigenous herb, of the woods, thickets, hedges, dry banks, and other shady places of Britain. Its root is tufted, ligneous, and somewhat creeping; its stem is cylindrical, branching, bushy, and about 20 inches high; its branches are axillary and leafy, and give the plant a compact and somewhat dense appearance; its leaves are very numerous, ovate or elliptical, and of various breadth; and its flowers are numerous, and grow in thick, forked, terminal panicles, and have a brilliant yellow colour, streaked and dotted with black or darkish purple, and bloom in July and August. This plant is disliked by horses and hogs, but eaten by cattle, sheep, and goats. Its leaves and flowers are strongly resiniferous, or oleiferous, and emit a powerful odour when rubbed; it bleeds under very slight compression or wounding, and imparts a blood-red colour to any spirituous or oleaginous substance with which it is mixed, and was formerly supposed to possess the power of healing wounds, bruises, and contusions; it is the *Fuga Dæmonum* of old herbalists, and was formerly held in great estimation for the fancied property of influencing conjurations and enchantments; it was, at one time, culled and carried about their persons by the peasantry of Scotland as a charm against witchcraft; it is still said to be gathered with great ceremony, on St. John's day, by the peasants of France and Germany, as a fancied preservative against thunder; and it yields a good yellow dye to woven fabrics from its flowers, and a good red dye from its leaves.

The square-stemmed St. John's wort, or St. Peter's wort, *Hypericum quadrangulum,* is a perennial-rooted indigenous herb of the moist meadows and thicketty river-banks of Britain. Its root is creeping and somewhat ligneous; its stems are sharply quadrangular, and grooved or convexly furrowed between the angles, and are erect, ramose, leafy, and about 20 inches high; its branches are short, opposite, axillary, and leafy, and arm the lower as well as the upper parts of the stem, but do not render the plant so bushy as the common St. John's wort; its leaves are sessile, ovate-elliptical, obtuse, and much veined, and cross one another in pairs, and are bordered with dark-coloured dots, and profusely sprinkled with very small pellucid ones; and its flowers sit on short footstalks at the ends of the branches, and have a lemon yellow colour, and are about half the size of those of the common St. John's wort, and bloom in July and August, and are succeeded by a profusion of readily germinating seeds. The dots on the borders of the leaves contain a blood-red liquid.

The Tutsan or Park-Leaves, *Hypericum androsæmum*—now regarded by some modern botanists as constituting a separate genus, under the name of *Androsæmum officinale*—is a perennial-rooted, indigenous herb of woods, moist shady lanes, and other similar places in some parts of Britain. Its stem has a shrubby appearance, and sends out some small branches toward the top, and usually attains a height of about two feet;

its branches are quadrangular, and somewhat compressed; its leaves are sessile, wide-spreading, and somewhat heart-shaped, and occur in pairs and oppositely at every joint; its flowers grow in small, erect panicles at the end of the stem, and are an inch in width, and have a yellow colour, and belong to the Linnæan group of diadelphia pentandria, and bloom from July till September; and its fruit is a three-celled, roundish capsule, covered with a moist pulp, and becoming black when ripe. Its leaves and other parts emit an aromatic odour when rubbed.

The large-calyxed St. John's wort, *Hypericum calycinum*, is a small undershrub, and grows wild in bushy places in some parts of Scotland, and especially of Ireland. Its root is creeping; its stems are ligneous, ramose, and from 12 to 18 inches high; its branches are smooth, simple, quadrangular, and leafy; its leaves stand on very short footstalks, and are coriaceous and ovately oblong; its flowers are two or three inches broad, and have bright golden yellow petals, and a multitude of reddish anthers, and bloom from June till September. This plant is highly ornamental in shrubberies, parks, and game-grounds, and may be readily propagated from suckers.

The doubtful or imperforate St. John's wort, *Hypericum dubium*—called by some botanists *Hypericum delphinense*—is a perennial-rooted indigenous herb of the moist groves and thickets of some of the mountainous parts of Britain. Its radical shoots have a bright red colour; its stem is quadrangular above, and about 3 feet high; its general form and appearance are similar to those of the common St. John's wort; its branches are lateral, long, and leafy; its leaves are larger than those of the common St. John's wort, not so green on the under surface, and almost free from pellucid spots; and its flowers have a yellow colour, dotted and clouded with dark purple, and bloom in July and August.

The trailing St. John's wort, *Hypericum humifusum*, is a procumbent, perennial-rooted native of the boggy and heathy pastures of Britain. Its root is fibrous; its stem is compressed, and trails along the ground; its leaves are elliptical and smooth, and have a similar odour to those of the common species; and its flowers are few, and have a yellow colour, and grow in a kind of cymes, and bloom in July and August. The highest part of this plant is seldom more than 6 or 8 inches above the ground.

The mountain St. John's wort, *Hypericum montanum*, is a perennial-rooted indigenous herb of the moist woods and moist thickets of Britain. Its stems are cylindrical, erect, smooth, and 18 or 24 inches high; its leaves are sheathing, naked, and ovate; its bracts and the dark fringes of its calyxes have a similar appearance to the glands of the moss-rose; and its flowers are yellow, and bloom in July and August. This plant is highly ornamental, and well deserves a place in the back part of the flower border.

The marsh St. John's wort, *Hypericum elodes*, is a perennial-rooted, indigenous herb of the spongy bogs and moss marshes of Britain. Its stems are procumbent, and seldom lift the highest part of the plant more than 6 or 7 inches above the surface of the ground; and its leaves are yellow, and bloom in July and August.

The hairy St. John's wort, *Hypericum hirsutum*, is a perennial-rooted, herbaceous indigen of thickets, hedges, and other shading growths, in dry calcareous soils, and particularly on chalky banks, in various parts of Britain. Its stem is about two feet high; and its flowers are yellow, and bloom in June and July.

The fair or small upright St. John's wort, *Hypericum pulchrum*, is a perennial-rooted herbaceous indigen of woods, thickets, and dense heaths, on argillaceous soils, in various parts of Britain. Its stem attains a height of about 20 inches; and its flowers are yellow and bloom in July.

The bearded St. John's wort, *Hypericum barbatum*, is a perennial-rooted herbaceous indigen of thickets and dense groves in some parts of Scotland. Its stem is about two feet high; and its flowers are yellow, and bloom from June till October. A variety of it called the Calabrian, *H. b. calabricum*, considerably smaller in size than the normal plant, was introduced to Britain about 30 years ago from Calabria.

The goat-scented or stinking or shrubby St. John's wort, *Hypericum hircinum*, grows naturally by the side of rivers in Calabria, Sicily, and Crete, and was introduced upwards of two centuries ago to Britain. It is a beautiful hardy shrub; and has long been in extensive request for its ornamental character. Its stems are 3 or 4 feet high; its main branches are smooth and of a light brown colour, and come out in pairs opposite to one another from the strongest stems, and send out subordinate branches which alternately point in different directions; its leaves are opposite, sessile, and oblong-ovate, and, when bruised, emit a very strong and disagreeable odour; its flowers are yellow, and bloom from July till September, and grow in such numerous and abundant clusters at the end of the young shoots that the shrub appears to be covered with them; and its fruit are oval, black-coloured capsules. Several varieties of this species are in cultivation. One of the most permanent of these, *H. h. minus*, is only about two-thirds of the height of the normal plant; another has strong stems, broad leaves, and large flowers, and can be coaxed up to twice the height of the normal plant; another has variegated leaves; and another boasts the important negative property of wanting the normal plant's abominable hircine smell.

Among the most handsome of the exotic hypericums, additional to the goat-scented species, are *H. canariense*, introduced about 150 years ago from the Canary Islands, an evergreen shrub of from 2 to 7 feet in height, carrying yellow flowers from July till September; *H. cochinchinense*, introduced about 26 years ago from Cochin-China, an evergreen shrub of 3 or 4 feet in height, carrying red flowers in July and August; *H. verticillatum*, introduced between 60 and 70 years ago from the Cape of Good Hope, a dwarfish evergreen undershrub of 8 or 10 inches in height, carrying yellow flowers in August; *H. coris*, introduced upwards of two centuries ago from the Levant, an evergreen undershrub of about a foot in height, carrying yellow flowers from the beginning of summer till the middle of autumn; *H. nummularium*, introduced about 24 years ago from the South of Europe, a deciduous trailer of about a foot in height, carrying yellow flowers in June and July; *H. triplinerve*, introduced about 26 years ago from North America, a perennial-rooted herb of about 20 inches in height, carrying yellow flowers in July; and *H. fimbriatum*, introduced about 26 years ago from the Pyrenees, a perennial-rooted herb of about two feet in height, carrying yellow flowers in July and August.

HYPNUM. A large, important, and extensively diffused genus of diploperistomous moss-plants. See the articles Bog and Mosses. Upwards of 60 species of this genus occur in Britain; and about as many more have been found in other countries. Of the indigenous species, *H. undulatum*, *reflexum*, *alopecurum*, and *brevirostre* grow in loose masses, *H. purum*, *blandovii*, and *loreum* grow in broad masses, *H. riparium*, *tenellum*, *serpens*, *populeum*, *stramineum*, *murale*, *silesianum*, *uncinatum*, *aduncum*, *squarrosam*, *polymorphum*, *confertum*, *velutinum*, *flagellare*, *proliferum*, *albicans*, *lutescens*, and *micans* grow in patches, *H. molle*, *molluscum*, *cuspidatum*, *cordifolium*, *crista castrensis*, *stellatum*, *splendens*, *curvatum*, *schreberi*, *catenulatum*, *prœlongum*, *striatum*, *triquetrum*, *rugulosum*, *palustre*, and *demissum* grow in tufts, *H. abietinum* grows irregularly, and *H. dimorphum*, *salebrosum*, and *denticulatum* grow in a procumbent or prostrate manner. The principal indigenous bog species are *H. aduncum*, *filicinum*, *scorpioides*, *albicans*, *trifarium*, *cordifolium*, and *laricinum*; the principal indigenous species which inhabit roots of trees are *H. denticulatum*, *serpens*, and *confertum*; the principal indigenous species which inhabit moist rocks and stones are *H. tenellum*, *catenulatum*, *molluscum*, *polymorphum*, *striatum*, *crassinervium*, *micans*, *flavescens*, *plumosum*, and *flagellare*; and the principal indigenous species which occur in woods, on hedgebanks, and in other similar shady places are *H. crista castrensis*, *prœlongum*, *schreberi*, *alopecurum*, *piliferum*, *blandum*, *dimorphum*, *striatum*, and *velutinum*.

HYPOCHÆRIS. See Cat's Ear.

HYPOESTES. A genus of ornamental tropical plants, of the acanthaceous order. Two evergreen undershrubs, with respectively red and white flowers, have been introduced to Britain from India; and two other species, of different character, from other parts of the world.

HYPOGLOSSUM. See Broom (Butcher's).

HYPOXIS. A genus of ornamental, herbaceous plants, constituting the type of the natural order hypoxideæ. The plants of this order are nearly allied to those of the amaryllis and the day-lily families; they have fragrant yellow flowers and linear leaves and a long and feeble pubescence; and they naturally inhabit Australia, Polynesia, the Cape of Good Hope, the Indian Archipelago, and some parts of North America. Upwards of 30 species, chiefly hothouse and greenhouse, and belonging to 3 genera, have been introduced to Britain.

Upwards of 20 species of the genus hypoxis have been introduced to Britain; and several more are known. The erect and the veratrum-leaved species, respectively 6 and 24 inches high, are hardy herbaceous evergreens; the slender, the ramose, and the rough, respectively 3, 6, and 9 inches high, are bulbous-rooted plants; the aquatic, 6 inches in height, is a greenhouse aquatic plant; and nearly all the other introduced species, ranging in height from 3 to 15 inches, are evergreen herbs, some of the frame or the stove, but most of the greenhouse. The great majority of the species love some degree of peatiness in the soil, and are propagated from offsets.

HYPTIS. A genus of exotic plants, of the labiate order. About 20 species have been introduced to British collections chiefly from the West Indies and tropical America; and about half as many more are known. Most are annuals or biennials; some have a curious appearance, with the limb of their corolla rolled over on its back; but the majority are interesting only to botanists.

HYSSOP,—botanically *Hyssopus*. A genus of useful and ornamental plants, of the labiate order. Six or seven species, all occurring in British gardens, were formerly included in it; but 3 or 4 of these are now assigned to other genera.

The officinal or common species, *Hyssopus officinalis*, is a native of Siberia, Austria, and the south of Europe, and was introduced from the last of these to Britain in the 16th century. Its root is perennial, ligneous, knobbed, and fibrous; its stem is shrubby, ramose, erect, somewhat quadrangular, and about two feet high; its leaves are sessile, elliptical, entire, about an inch in length, about one-third of an inch in breadth, and of a deep green colour, and grow in pairs; and its flowers have a bluish violet colour, and grow in long, half-verticillated, terminal spikes, intermixed with leaves, and bloom from June till September.—The leaves of this plant have a pleasant aromatic odour, and a somewhat warmish and bitterish taste; they seem to owe their peculiar properties to the presence of a yellowish volatile oil, which can be separated by distillation; and they are used in infusion as a gentle tonic and stimulant, or as a beverage in lieu of tea, and have been recommended for hysteria, and were formerly used, though with very doubtful propriety, as an expectorant in catarrhal and pulmonary affections.—Common hyssop is most luxuriant on a rich moist soil, but hardiest, most aromatic, and in all other respects most desirable on ordinary dry garden soil. It may be propagated either from seeds, or from slips and offsets. The seeds may be sown at any time from the beginning of March till the end of May, either broadcast, or in drills six inches apart, but never deeper than about half an inch. Cuttings of branches may be planted in April or May; slips of young shoots, in June or July; and rooted offsets, either in April or May, or in August or September. Cuttings and slips do best to be planted in a shady border, and transplanted in the course of about two months. A copious watering must be given after every planting and transplanting; and every final removal for the year, or into the permanent situation, may be done in September or October.—Two varieties of the common hyssop occur in some gardens, and are esteemed chiefly on an ornamental account,—the variegated-leaved, *H. o. variegatus*,—and the red-flowered, *H. o. flore-rubro.*

Schleicher's hyssop, *Hyssopus Schleicheri*, was introduced to Britain about 28 years ago from Switzerland. It was regarded by the Swiss botanist whose name it bears as only a variety of the common hyssop; but it is really a distinct species, and usually attains but half the height of the common species.—The oriental or narrow-leaved hyssop, *H. orientalis* or *H. angustifolius*, is a native of the Caucasian Mountains, and has both a similar habit and a similar height to the common hyssop.—The species which have been removed to other genera are wholly herbaceous.

I

IBERIS. See Candytuft.

IBEX. See Goat.

IBIS. A genus of birds, of the long-billed family of waders. They are nearly allied to the snipes and the curlews. The sacred ibis, *I. religiosa*, was reared in the temples of ancient Egypt, and treated with a degree of heathenish reverence amounting almost to adoration. The green or glossy ibis, *I. falcinellus*, is a beautiful bird of northern Africa and southern Africa, and makes rare, and perhaps merely accidental, visits to Britain. It is about 22 inches long, and has a purplish brown-red colour, with a mouth of deep green. Some ornithologists, on the strength of its occasional visits to us, rank it as a British bird.

ICE. Every frozen liquid,—in a more limited sense, frozen water,—is known by the term ice. As soon as the temperature is raised, the solid state again gives way to the liquid. We see, then, that ice is nothing but water deprived of its caloric. The freezing of water is a phenomenon so remarkable, that the greatest naturalists have thought it worthy of a careful investigation. Expose a glass, filled with water, to a degree of cold producing ice. An extremely thin film of ice is observed first on the surface of the water in contact with the cold air. Slender threads of ice are soon seen to shoot out from the sides of the vessel, generally forming with it obtuse or acute, seldom right angles; from these rays, new ones continually shoot out, till the whole surface is covered with a single coating. While this process is going on, a great number of air-bubbles arise, as in boiling, which pass out of the water when the congelation is slow; but when it is sudden, they are frozen in, and by their expansion cause rents in the ice. Although cold generally produces contraction, ice occupies a larger space than water; it is hence specifically lighter, and floats upon it. Those persons are in an error, who suppose that *ground-ice*, as it is called, rises from the bottom of the water after freezing. A kind, however, called *anchor-ice*, appears to be formed at the bottom, or, at least, under the surface, of rapid rivers, perhaps owing to the comparatively slow motion of the water at the bottom of a stream. It is well-known that stagnant water freezes sooner than flowing water; perfect rest, however, seems to be unfavourable to freezing, for we know by experience, that water perfectly still is not frozen when its temperature is reduced much below the freezing-point; but a little agitation is sufficient to change it into ice. Sea-water, and in general all salt water, freezes with greater difficulty, because the salt and other ingredients retain the caloric longer. Salt is, moreover, separated in the process of freezing, and precipitated to the bottom; so that ice from sea-water sometimes affords potable water. Salts, however, produce a degree of cold beyond the freezing temperature; and, by means of them, we can cool water much below the freezing point, while it still remains fluid. Most salts have this property, especially nitre, muriate of ammonia, and common salt. A degree of cold sufficient for the freezing of water may be produced by them in summer, or even over a fire. Artificial ice is formed, also, by exposing pure water, in proper vessels, to such freezing mixtures. The more severe the cold, the greater the hardness and firmness of the ice; and the ice of the polar regions can hardly be broken with a hammer.

Artificial Ice.—The Greeks and Romans used various means to preserve snow and ice to cool their drinks: still they never carried this art to such perfection as the moderns have done. We are now better acquainted with the means of producing artificial cold. Experience teaches us, that cold arises from the evaporation of liquids. With vitriolic ether, and still better with nitric ether, artificial ice may be produced in this way, in the middle of summer and on the warmest days. Ice is formed in the East Indies, in Calcutta, and other places, principally by evaporation. In the level countries there, snow and frost are never known; but in order to have cooling materials in the heat of summer, the inhabitants collect snow and ice, during the winter, from the high mountains, and throw portions of it into small earthen pans, unglazed, which at sun-down are filled with water. The pans are inserted in the earth, two feet deep, covered with dry straw, and evaporation is then suffered to go on. In clear weather, so much caloric is absorbed from the remaining water by this evaporation, that, with the help of the snow floating in it, the whole becomes ice; this is then put in deep caves before sun-rise, and preserved for summer. About the middle of the 16th century, the custom of cooling drink with saltpetre was introduced into Italy. Afterwards, the method of increasing the cold of snow and ice by a mixture of saltpetre became common. The preparation of artificial ice gradually became more usual; and what was at first only an experiment, at length became an object of luxury. In the beginning of the 17th century, ice-cups were introduced, and fruits frozen in ice were brought upon the tables. Soon after, the French began to freeze the juices of all savoury fruits for desserts.

ICELAND MOSS,—botanically *Cetraria Islandica.* A cellular medicinal plant, of the cœnothalamous tribe of lichens. It is a perennial indigen of rocky places in Britain; it abounds in Iceland and the north of Germany; and it occurs, with greater or less frequency, on the heaths and mountains of all the northern parts of Continental Europe. It has a bushy and rugged appearance, but attains a height of only about 2 or 2½ inches. Its colour is greenish-yellow or olive-brown; its frond is lobed, laciniated, dry, and leathery; and its lobes are smooth, shining, and blistered, and have an armature of minute stiff hairs upon their margin, and are so peculiarly notched and subdivided as to look like miniature resemblances of buck's-horns. The dried plant has a closely similar appearance to the fresh one; and is inodorous, and has a bitter mucilaginous taste, and cannot easily be reduced to powder. When steeped in water, it imbibes more than its own weight of the liquid, and becomes diaphanous; and when afterwards boiled in water, it makes a yellow-coloured decoction, which cools into a thick, tremulous, starch-like jelly. The principal constituents of Iceland moss, according to analysis by Dr. John, are about 37½ per cent. of insoluble matter, about 40 of mucilage, about 10 of extractive matter, and about 8 of inuline.

The Icelanders and Laplanders use the Iceland moss as an article of diet, both by drying it and making it into bread, and by repeatedly macerating it in water, and boiling it in milk or broth. The dried plant figures among the materia medica of all the pharmacopœias of the three kingdoms. It came into notice as a medicinal plant between 70 and 80 years ago, and was for some time extolled as almost a specific for consumption; and, though it sadly failed to realize the expectations which were cherished respecting it in pulmonary complaints, it has earned a permanent character for allaying tickling coughs, for relieving difficult breathing, for alleviating debility and emaciation after acute diseases, and generally for acting as a demulcent and a tonic. Some ignoramuses regard lichen and Iceland moss as strictly convertible terms; and even the London pharmacopœia absurdly uses the general name lichen, instead of the particular name Cetraria Islandica.

ICE PLANT,—botanically *Mesembryanthemum crystallinum.* A singular plant which has received this appellation from the little transparent vesicles which cover its whole surface. The stems are herbaceous, as large as the little finger, spread upon the ground, and very much ramified; the flowers are white, and, as in the rest of the genus, furnished with a great number of linear petals, which give them the appearance of compound flowers, though belonging to a very different family. It is a native of the sea-coast of South Africa, the Canaries, and is also found in the vicinity of Athens. The other species of Mesembryanthemum, upwards of 300 in number, forming one of the most numerous and remarkable genera of plants, are principally confined to South Africa, and constitute a marked feature in its vegetation. See the article MESEMBRYANTHEMUM.

ICHNEUMON. A genus of insects, of the pupivorous family of hymenoptera. Their head is transversal, and their abdomen is somewhat oval, and almost equally narrowed at both ends. But the whole tribe ichneumonidæ, of which this genus is the type, possesses much interest to the farmer and the gardener, and is readily distinguishable by both its characters and its habits. The antennæ of its species are generally filiform or cetaceous, seldom clavate or multiarticulated, and always composed of at least 16 joints; the mandibles of most have no tooth on the inner side, and terminate in a bifid point; the maxillary palpi generally consist of but five joints, and are always apparent or salient; the wings are veined; the superior wings have always complete or closed cells in their disk; the abdomen originates between the two posterior legs; and the ovipositor consists of three setæ or threads, which are frequently curled, and have a whitish or yellowish annular spot in the middle. Upwards of 1,200 species have been described; and probably a very considerable number more exist.

The ichneumonidæ destroy very many kinds of insects which are injurious to cultivated plants; they destroy the ovules of some, the larvæ of others, the pupæ of others, and particularly the larvæ or caterpillars of many butterflies and moths; and they very generally effect their purpose as entozoons or parasites, their ovules being deposited in the bodies of the prey, and their larvæ subsisting on that prey as food. The intermediate one of the three setæ which constitute their ovipositor is that which penetrates the bodies of the prey; and its extremity is flattened, and sometimes resembles the nib of a pen. Such of the ichneumonidæ as have long ovipositors deposit their ovules in the fissures or under the bark of trees; and such as have very short ovipositors deposit their ovules directly in exposed or very accessible pupæ, larvæ, or caterpillars. The females, when anxious to lay, may be seen in constant and busy motion, walking, running, or flying to discover fissures, ova, pupæ, larvæ, caterpillars, spiders, or aphides, in which they may make their deposits; and they display great skill and most penetrating instinct in the search, and speedily discover the deepest and most secret retreats of the fittest kinds of prey.

"The larvæ of the ichneumonides," says Cuvier, "are destitute of feet. Those which, in the manner of intestinal worms, inhabit the bodies of larvæ or caterpillars, where they sometimes form communities, only attack the adipose substance, or such of the internal parts as are not necessary to their existence. When about to become nymphs, however, they perforate their skin in order to open a passage, or put them to death, and there tranquilly undergo their ultimate metamorphosis. Such also are the habits of those which feed on nymphs or crysalides. Nearly all of them spin a silken cocoon, in which they become nymphs. These cocoons are sometimes agglomerated, either naked, or enveloped in a sort of tow or cotton, in an oval mass, frequently found attached to the stems of plants. The symmetrical arrangement of the cocoons of one species forms an alveolar body, resembling the honey-comb of our domestic bee. The silk of these cocoons is sometimes of a uniform yellow or white, and sometimes mixed with black or filaments of two colours. Those of some species are suspended to a leaf or twig, by means of a long thread. Reaumur has observed that, when detached from the bodies to which they are fixed, they make repeated jumps to about the height of four inches, the larva enclosed in the cocoon approximating the two extremities of its body, and then suddenly returning to a straight line, in the manner of various skipping larvæ of dipterous insects found in old cheese."

ICHNOCARPUS. A small genus of ornamental, tropical plants, of the dog's-bane tribe. The frutescent species, *I. frutescens*—called by Linnæus *Apocynum frutescens*—is a native of India, and was introduced, soon after the middle of last century, to the hothouses of Britain. It is an evergreen shrub of 10 or 12 feet in height, and carries purple flowers about the beginning of autumn.

ICICA. A genus of ornamental, dendritic, balsamiferous, tropical plants, of the terebinth family. Four species, all white-flowered evergreen small trees, and varying in height from 20 to 35 feet, have been introduced to the botanical collections of Britain; and about a dozen more are known. One of the introduced species, *Icica heterophylla*—called by some botanists *Amyris heterophylla*—yields the balsam known in commerce as the balm of Acouchi; another of the introduced species, *Icica guianensis*—called by some botanists *Amyris guianensis*—yields a gum or exudation, which makes one of the best of known varnishes; one of the unintroduced species, *Icica leptophylla*, also yields a valuable gum; and nearly all the species, whether introduced or unintroduced, afford fine material, in both their resin and their wood, for fragrant incense and delightful pastiles. See the articles Frankincense and Terebinth.

ICOSANDRIA. See Botany.

IGNITION. A luminous and greatly heated but undecomposing condition of a liquid or a solid body. Its lowest degree is in the commencement of what is called red heat; and its highest degree is at the maximum of what is called white heat. Ignition is "fire," without either flame, combustion, expansion, or vaporization; it combines indecomposition of substance, with the emission of light, and the presence of a very high temperature; and it is supposed to consist —though the theory is by no means satisfactory —in the evokement and liberation of latent light by the action of excessive heat.

ILES. The awns of barley, and awn-like processes of cereal and other grasses. The name is provincial.

ILEX. See Holly and Oak.

ILLECEBRUM. See Knotgrass.

ILLICIUM. See Aniseed-Tree.

IMBIBITION. See Absorption in Plants.

IMBRICATION. The overlapping of the petals of some double flowers, and of the scales of some fruits. The name is formed from a word signifying "a tile;" and literally means an overlapping like that of tiles on the roof of a house. Two of the most familiar applications of it occur in the overlapping varieties of the camellia, and in the overlapping kinds of cones and acorns.

IMPATIENS. A genus of ornamental plants, principally annuals, of the balsam family. One species grows wild in England; and about sixteen species have been introduced from foreign countries. The capsules of all the species, when nearly ripe, have a peculiar and very keen irritability; and, when but slightly touched, they curl up, burst open, and scatter their seeds in all directions, and to a considerable distance. This irritability is alluded to in the botanical name impatiens, and has occasioned the indigenous species to be popularly called touch-me-not; yet it is a property possessed by the whole family of balsamineæ. The valves of the capsules consist of cellules, which very gradually diminish in size from the exterior to the interior surface; the outer cellules contain the densest fluid, and, by a process of infiltration, gradually empty the inner cellules, and distend themselves; so that, whenever their relative position is disturbed by accidental pressure or by the disarticulation of the valves, the external tissue expands, the internal tissue contracts, each valve rolls rapidly inward, and the seeds are instantly and jerkingly ejected. Though only about sixteen exotic species have been introduced to Britain, and seldom more than a score are enumerated by botanists; yet 47 species are named by Wallich from Sylhet, Nepaul, Pundooa, and the Indian peninsula, a great many species occur in Ceylon, and at least 100 species occur in those districts of India from which Roxburgh described only three.

The touch-me-not or yellow impatiens, *I. noli-tangere*, grows wild in shady and humid places in England, and in many parts of Continental Europe. Its root is annual; its stems are erect, succulent, fleshy, ramose, and between two and three feet high; its leaves are narrowish, ovate, somewhat square at the base, and saw-edged; and its flowers grow in axillary clusters of three or four together, and are large and have a pale-yellow colour, dotted with small red spots near the centre, and bloom from June till September. The leaves of this species—and also those more or less of all the other species—are generally expanded in the day-time and pendent or deflected at night; yet whenever they have not a due supply of moisture, they speedily droop and remain pendent,—and whenever they obtain a supply, they speedily revive. The touch-me-not is said to have very acrid and dangerously diuretic properties, and to be eaten by no domestic animals except goats. It has long been grown in gardens as a curiosity; and it succeeds best when allowed to sow itself; for unless its seeds are sown in autumn, very soon after they are ripe, they very rarely germinate.

The tawny-flowered or two-flowered impatiens, *I. fulva* or *I. biflora*, occurs wild in Surrey and some other parts of England, and seems to have been for some time confounded with the common touch-me-not, and is closely similar to that species in manner of growth; yet it was really introduced at some unknown period from North America, and became an apparent native of Britain only as an outcast from some garden. It grows wild within the very limits of the spray of the Falls of Niagara. Its stems are between two and three feet high; its leaves are ovate, and taper to the base; and its flowers are small, and yellow or orange-coloured, spotted with red on the inner surface, and bloom from June till September.

The white-flowered impatiens, *I. candida*, is a stately and very handsome annual, from the Himmalayan mountains. Its stem is bright green, succulent, obscurely quadrangular, and branched to the very ground, and attains, in favourable circumstances, a height of about 6 feet; its leaves are narrowly lanceolate, and are edged with minute crimson serratures, and taper to a fine point, and generally grow in whorls of three; a row of small crimson glands occurs between the leaves forming the whorls; and the flowers grow in loose terminal umbels, and are large and showy, and have a white colour slightly speckled with crimson, and are produced in succession throughout the autumn. This plant grows freely, and blooms abundantly, when treated in the open ground as a half-hardy annual; but in order to be coaxed into even a moderate display of its eminent delicacy and beauty, it must be treated in the greenhouse in the same manner as the common garden balsam.

The small pink impatiens, *I. rosea*, is another beautiful half-hardy or greenhouse annual, from the Himmalayan mountains. Its stem is erect and succulent, and attains a height of 4 or 5 feet, but is much less branching than that of the preceding species; its leaves are alternate, linear-lanceolate, edged with minute serratures, and from 6 to 8 inches long; its flowers are small, and have a delicate rose colour, and grow in clusters, on blood-red stalks, from the axils of the leaves; and its capsules are oblong, and covered with a thick, white, woolly-looking pubescence. Its gathered flowers are said to last for several weeks without fading.

The scape-flowered, stemless, or tuberous-rooted impatiens, *I. scapiflora*, *I. acaulis*, or *I. bulbosa*, is a dwarf stove perennial, and was introduced to Britain about 12 years ago from Bombay. Its tuberous roots resemble those of some species of begonia; its leaves grow from the root-crown, and are smooth and heart-shaped, and present a considerable resemblance to those of some kinds of begonia; and its scape or flower-stem rises to the height of from 9 to 12 inches, and produces 6 or 8 large, delicate, purple-rose or pale-lilac flowers, which have a very peculiar form, and usually bloom in August.

The chief of the remaining introduced hardy species, are *I. triflora*, pale-red flowered and a foot high,—*I. cristata*, yellow-flowered and 2½ feet high,—*I. parviflora*, yellow-flowered and one foot high,—*I. pallida*, pale-flowered and 15 inches high,—*I. tripetala*, red-flowered and one foot high,—and *I. borealis*, yellow-flowered and 3 or 3½ feet high; and the chief of the remaining introduced tender species, are *I. macrochila*, pale rose-colour flowered, and 8 or 10 feet high,—*I. glanduligera*, deep rosy purple colour flowered and from 6 to 12 feet high,—*I. longicornu*, yellow and fragrant flowered, — *I. coccinea*, red-flowered and 2 or 3 feet high,—and *I. natans*, variegated-flowered, with red, white, and yellow, and from 2 to 3 feet high. But the last of these is a very rare stove aquatic, with a piped stem floating in the water, and emitting roots from the joints.

IMPERATA. A small genus of exotic grasses, of the villiflorous or sugar-cane tribe. The spontaneous species, *Imperata spontanea*—called by Linnæus *Saccharum spontaneum*—is a beautiful, perennial-rooted, native of Africa, about 40 inches high; and was introduced about 23 years ago to the botanical collections of Britain. The reedy-species, *Imperata arundinacea*, is a hardy perennial of the South of Europe, about 30 inches high, used in its native regions for economical purposes, and introduced, about 30 years ago, to Britain.

IMPERATORIA. See MASTERWORT.

IMPLEMENTS (AGRICULTURAL). Most of the operations of agriculture, in a half-rude state of society, may be performed by means of merely the plough, the harrow, the sickle, and the flail, or of implements similar to these; and all the operations of very small farms, even in very improved states of society at the present day, may be performed by means of simply the plough, the harrow, the roller, the cart, the wheel-barrow, the spade, the shovel, the pick, the hoe, the scythe, the flail, and the rake.

But the implements of agriculture, proper for large and for middle-sized farms, are very advantageously capable of great multiplication and improvement: and, within the last half century, they have been actually multiplied and improved to a degree which has wonderfully enhanced the productiveness of our country and the general interests of agriculture. A remark made by Dr. Anderson in 1802, in reference to the older classes of implements, has been very abundantly verified, "that there are no sort of implements which admit of greater improvement than those of husbandry, on the principle of diminishing weight without in any degree abating their strength;" and a remark of similar value may be made in reference to the newer classes, that they admit of a multiplicity of nice and useful adaptations, without requiring any such excessive complication of parts as characterises the principal implements and machinery of the textile manufactures.

Yet a large proportion of the new inventions, offered from time to time either as improved forms of old implements or as novel means of lessening or superseding manual labour, have proved either useless or absurd; and these have all along and very extensively created new prejudices, and magnified old ones, against the ready and confident adoption of the really improved implements. Some hindrances to enlightened and rapid improvement, occur in the want of due co-operation between practical farmers and professional implement-makers; some, in the backwardness of most farmers to encourage a real improvement; some, in the fondness of many implement-improvers to act more in the light of theory than in that of observation; and some, in the intrinsic difficulty of adapting the laws of mechanics to the particular forms of some desiderated constructions. "Most farm operations," says Mr. Stephens in his Book of the Farm, "being of themselves simple, should be performed with simple implements; and all the primary operations, which are simple, requiring considerable power, the implements executing them should also be strong; but complicated operations, though stationary, require to be performed with comparatively complicated machinery, which being stationary may be used without fear of derangement. Operations, both complicated and locomotive, should be performed with implements producing complicated action by simple means, in order to avoid derangement of their constituent parts. This last is a difficult, if not impossible problem, to solve in practical mechanics. The common plough approaches more nearly to its practical solution than any other implement; yet that truly wonderful implement, executing difficult work by simple means, should yet be so modified in construction, as to permit the ploughman to wield it with greater ease. These considerations tend to shew that the form and construction of implements of husbandry, and the circumstances in which they may be used, are still subjects affording ample scope upon which mechanical skill may exercise itself."

The principal existing and approved implements for preparatory tillage are the several kinds of ploughs, harrows, grubbers, and rollers; the principal for sowing, are the dibbling machines, the drill machines, and the several classes and varieties of sowing machines; the principal for the cleaning and cultivating of growing crops, are the several kinds of hand-hoes and horse-hoes; the principal for harvesting and hay-making are reaping-machines, horse-rakes, hand-rakes, scythes, and sickles; the principal for the operations of the barn, are the thrashing-machine, the winnowing-machine, the hummeller, and a considerable number of hand-instruments; the principal for the preparing of farm-yard food are bruising-rollers, chaff-cutters, turnip-slicers, the furze-cutter, the oil-cake breaker, and the apparatus for boiling and for steaming; the principal for the dairy are churning-machines, hand-churns, cheese-presses, and cheese-rack; the principal for carriage are waggons, carts, liquid manure carts, and wheel-barrows; the principal for miscellaneous works of georgy and farm-improvement are subsoil-ploughs, draining implements, hedging-tools, tile-making apparatus, bone-mills, felling-saws, and many others; the principal for miscellaneous purposes on the farmery are pumps, smearing syringes, handbarrows, weighing-machines, and some others; the principal for miscellaneous purposes in the field are gates, stone-lifters, odometers, dendrometers, levelling instruments, and a few others; and the principal for general or miscellaneous manual labour are spades, shovels, picks, saws, axes, hammers, forks, hoes, rakes, ladders, knives, scissors, brushes, and many more. Almost every implement or class of implements, whether of prime importance or of comparative insignificance, is described in its own alphabetical place in our work.

Every implement of a farm, especially every one of the more complicated and valuable class, ought from time to time to be minutely inspected, in order that any part of it which has received damage or undergone derangement may be immediately repaired; for when even a very small or very limited injury has been sustained, a large portion of the implement may soon become seriously and expensively affected, or absolutely the whole be rendered unfit for use. All moveable implements, also, ought, whenever they are not wanted, to be thoroughly cleaned, and carefully stored, the larger ones in sheds, cart-houses, and plough-houses, and the smaller ones in the implement-house. Machines and implements, likewise, which are much exposed to the weather, ought, every two years or so, to receive a new coat of paint, as a means of protecting them from the effects of both drought and rain. "We suggest to farmers generally," say Messrs. Ransome, "that a little instruction given to the workmen in the use of the machines, and care in preserving them, would add to their efficiency and durability. Attention to washing implements and machines before laying them by, a little oil on such as have revolving wearing parts, and a coat of paint occasionally to each, will cost but little, and make the difference between having a machine ready for use, or covered with rust and wanting repair just as the season for its use commences." "I would advise farmers," says Mr. Crosskill, "to contrive by care and good management to make the implements as durable as possible. The cost of this will be trifling, compared with the advantage. In order to effect it, select the most likely agricultural labourer upon the farm; put the implements under his care; make it a strict rule with all the men that each implement done with for the season shall be brought to one particular place, say near the pond or pump; the man having charge of the implements must then wash and clean them well before putting them into the shed, and at a convenient time, when not otherwise engaged, or in weather when outdoor work cannot be performed, get them repaired and paint them. At the end of this shed or implement house, there might be a lock-up workshop, with door to open into the place, with a few tools, paint-pots, &c., the expense of which would not exceed £5. The man should be encouraged to make his duty a pleasure, and to feel a pride in showing his master's implements in fine order."

IMPLEMENTS (Horticultural). The indispensable implements of the garden, or those which may suffice either in remote districts or in half-rude ages, are very few and simple,—probably not more than the spade, the rake, and the pruning-knife,—or even merely the first of these and some rude substitutes for the second and the third. But the implements in use amidst the improvements and the refined practices of the best or even middle-rate British gardening of the present day, are very numerous and diversified. Among the most important, including appliances as well as instruments, are axes, averuncators, fumigating bellows, rustic chairs, pruning-shears, pruning-chisels, pruning-knives, pruning-bills, dibbles, watering-pots, watering-pans, watering-engines, edging-irons, forks, hand-glasses, hedge-gloves, hammers, hatchets, hedge-bills, hoes, mats, measuring-tapes, protecting-nets, plant-protectors, picks, mattocks, rakes, reels, riddles, saws, grape-scissors, propagating-scissors, hedge-shears, box-shears, grass-verge shears, scythes, spades, shovels, syringes, trowels, weed-hooks, weeding-irons, traps, thermometers, hygrometers, and the various apparatus for producing and regulating the heat of hot-beds and forcing-houses.

IMPROPRIATIONS. In the English church, benefices in the possession of laymen; those annexed to ecclesiastical corporations being called *appropriations*, though they are sometimes identified. Blackstone gives the following account of them. Benefices are sometimes appropriated, that is, perpetually annexed to some spiritual corporation, either sole or aggregate, which the law esteems as capable of providing for the service of the church as any single clergyman. This contrivance sprang from the policy of the monastic orders, who begged or bought all the advowsons within their reach, and then appropriated the benefices for the use of their own corporation. Such appropriations could not be completed without the king's license, and the consent of the bishop. When it was once made, the appropriators and their successors became the perpetual parsons of the church. Blackstone is of opinion that appropriations may still be made in this way. Those formerly made, were originally annexed to bishoprics, prebends, religious houses, manories and certain military orders; but on the dissolution of the monasteries in the reign of Henry VIII., the appropriations of the several parsonages belonging to them were given to the king, and were afterwards granted out, from time to time, by the crown. The appropriator deputed some person to perform divine service in such parish, who, being merely his deputy or vicegerent, was called *vicar*, whose stipend was at the discretion of the appropriator. The distinction, therefore, of a parson and vicar, is that the former is entitled to all the ecclesiastical dues of his parish, while the vicar is, in effect, only the curate of the real parson (the appropriator), and receives but a part of the profits. It is computed that there are 3845 impropriations in England.

IMPROVEMENT OF LAND. The improvement of land may be understood in the sense either of rendering desert and waste lands profitable, of rendering pastoral lands arable, or of rendering arable lands increasingly fertile. The operations for it, in the first and the second senses, require, for the most part, to be conducted on a great scale, by landlords alone, and with reference rather to estates than to farms; and they will be found discussed, in all their main departments, in the articles HEATH-LANDS, WASTE-LANDS, GRASS-LANDS, DRAINING, and SUBSOIL-PLOUGHING. But the operations for rendering arable lands increasingly fertile, and also some limited instances of rendering pastoral land arable, or even of rendering waste lands profitable, may be conducted on the very smallest scale, and concern the tenant fully as much as the landlord, and have reference either to farms or mere parts of farms, and comprise very nearly all the practices and appliances of at once reclamation, draining, textural change, tillage, manuring, cultivation, and system of cropping.

The grand power for improving farms is education. Tenants who live in ignorance and doltishness, and have little or no knowledge of the principles of agriculture, and conduct the work of their farms in blind imitation of the practices of their fathers, will never improve land except as they are coaxed or compelled; and tenants of an opposite character, well-behaved, intelligent, industrious, and wishful to make the best use of the knowledge they have and to obtain speedy and frequent acquisitions of more, will improve land in all the ordinary course of cultivating it, often without other aim than the increase of present advantage, and sometimes in the total absence of encouragement from man, or even in spite of ridicule and opposition. A sure though slow way, therefore, of improving the tenanted arable lands of an estate—and likewise both a necessary auxiliary to every more direct way, and by far the best guarantee for a maximum of eventual and permanent good—is to enlighten the present race of farmers as fully as possible by means of example, of conversation, of books, and of agricultural associations, and to enrich their sons or other apparent successors with the largest attainable amount and the utmost possible variety of sound professional education. See the articles AGRICULTURAL EDUCATION and AGRICULTURAL SCHOOLS.

Improvements of any kind involving direct expense, whether draining, enclosing, planting, building, or whatever else, do not give the tenant any claim upon the landlord, except by special agreement; so that they may be expected to be made by even the most intelligent and industrious, only when the period of unexpired lease is sufficiently long to let them obtain remunerating advantages from them, or when a fair proportion of the cost of them is borne by the landlord. Any three tenants may be fully aware of the value of certain improvements, and even very desirous that they should be made; but one feels that he has not sufficient capital to undertake them,—another, that he has not a long enough lease to realize a compensating benefit from them,—and another, that, even though he had the longest lease which the usages of the country warrant, he could not profitably expend upon them more than a certain portion of the requisite cost. In all such cases, the landlord and the tenants ought, for the sake of their common advantage, to consult together, to understand each other, and to co-operate. "Were the landlord always a party, neither the duration of leases, nor the expense, would, in general, have the slightest effect; improvements would proceed with equal rapidity at the termination as at the commencement of leases; and the execution of the work would always be of the most efficient kind. Both parties are probably disposed to take rather a partial view of the relation in which they stand to each other, and to overlook this important fact, that, in almost all improvements, their interests are inseparably united, and that the greatest benefit can result only from the parties uniting, and each bearing a share of the expense proportionate to their interest in the concern.

An intelligent tenant may distinguish between comparatively temporary and comparatively permanent improvements, or between such as will yield the whole of their results during the unexpired period of his lease, and such as will prolong a considerable portion of their results beyond the termination of that period; and he will readily undertake the former entirely on his own responsibility; but, in reference to the latter, if his landlord refuse to bear a due proportion of the expense, he will either decline them altogether, or perform only such as can be advantageously executed in a slim or imperfect manner, and with fair prospect of remunerativeness before the expiry of the lease. A comparatively permanent improvement on a lease of five years may be a comparatively temporary one on a lease of ten; and a comparatively permanent improvement on a lease of ten years may be a comparatively temporary one on a lease of twenty. Even ordinary manuring, the least durable of improvements, is comparatively permanent to a tenant of only two years; and either his successor or his landlord ought to bear a part of the expense, rather than allow this operation to be insufficiently performed. "In the case of lime, too, it may become the interest of a proprietor to assist his tenant upon a short lease; by which the latter might be enabled to pay a much higher rent. Hence the practice in many counties of England, when land is let either from year to year, or upon very short leases, of having a fixed valuation for different improvements, estimated according to their duration; so that a tenant may, with confidence, execute the most permanent improvements, because he is assured of repayment, either by retaining his possession, or by receiving their value, should he be obliged to quit."

The chief comparatively permanent improvements on farms held under the longest ordinary leases, or on leases of from 15 to 21 years, are draining, enclosing, building, planting, and road-making; and as these, when properly done, may be estimated to last during the long period of from 50 to 100 years, they must, in all equity, be performed, not only with the concurrence and co-operation of the landlord, but mainly at his expense and entirely at his control. They require, at once for their own sake, and for the sake of their collateral advantages, and on account of their moral influence upon the stimulating of the agricultural community, to be executed well; and they cannot possibly be executed in any but the slimmest and most disheartening manner, if indeed they can be executed at all, by any mere tenant in possession of even the longest ordinary lease. Draining and enclosing and building, indeed, may, in any case, be done by a leaseholder of 21 or even 15 years; but they will be done so superficially as to yield no advantage to the landlord, to discourage improvements on neighbouring farms, and to afford less profit to the tenant himself than if, with due help and control from the landlord, they were executed well. Draining, in particular, may be so performed as to serve very remuneratingly the purposes of the tenant, and then leave such encumberment on the land as to interpose both difficulty and cost in the way of further improvement. Landlords, therefore, ought, by all means, were it from no higher motive than sheer concern for their own interest, to undertake and direct all comparatively permanent improvements,—and to undertake them, not upon isolated farms, but upon their whole estates.

"But a very proper question may now be asked, How are proprietors to effect this much-to-be-desired object—the thorough improvement of their estates? Themselves unacquainted with the subject, who are to be entrusted with the management of the work? In answer, I may remark, that when a proprietor who is not a practical agriculturist resolves to improve his estate, the work should be entered upon with the greatest caution. By hastily and imprudently commencing extensive operations, or by giving assistance to tenants without having previously fixed upon proper plans of improvement, and then discovering that their properties are not permanently benefited, many proprietors have resolved not again to engage in works of the kind. Such resolutions, I know, have followed the outlay of considerable sums. But the failure is owing to the practice, not the principle, being wrong. As land may be deemed an article of commerce, both the proprietor and the cultivator of the soil expect to receive an adequate return for capital invested. Hence, every proprietor is as well entitled to receive a fair rate of interest for capital invested in improvements, by which the land is increased in its annual value, as he is for that which was invested in the purchase of the land itself. It should, therefore, be adopted as an invariable rule, never to lay out money upon improvements without being certain—that is, as certain as the nature of the speculation will admit of—of receiving a fair return, either immediate or prospective. And, in order that he may not blindly enter into the speculation, he ought, if not a competent judge himself, to appoint one in whom he has confidence, to report as to the plan of improvements; but, even with all the information he can obtain in this way, in order fully to satisfy himself, it would be advisable that he undertake an operation of the kind upon a small scale, and lay out say £50 or £100 in effecting a thorough improvement on a piece of ground, and the result will in one season prove whether the speculation is likely to be a paying one or not.

"This naturally leads to another question. Assuming that land will give an adequate return for capital invested in improvements when let on lease, what portion of the outlay ought the tenant to bear? To this no precise answer can be given. Of the various plans of dividing the expense which have been suggested, that of the proprietor laying out the money, and the tenant paying a certain rate of interest, has not only the advantage of simplicity, but gives to the proprietor, whose chief benefit is to be derived from the permanency of the improvement, the power of executing the work in any way he thinks proper. And in regard to the rate of interest, six per cent. has been stated as a fair return; and, no doubt, taken as an average rate, it may be perfectly fair. But it is quite evident that, in practice, this must be varied by many collateral circumstances, such as the length of lease, and the nature of the land upon which the improvement is proposed to be effected. Upon land of naturally good quality requiring nothing more than draining, by which an immediate return would be obtained, a tenant may, with advantage, pay the highest rate of interest; and on the other hand, when it is left to a tenant to apply the trench-plough, remove large stones, and execute other expensive works, in order to bring the land into a proper state of cultivation, then the return to the tenant, as well as to the proprietor, must be prospective; and hence in justice a very small, if any, interest should be paid for several years. I may, however, remark, that upon this subject some very erroneous opinions have been formed. It is alleged by many, that as this species of improvement yields a large return, therefore, the proprietor, who does the whole at his expense, ought to receive a rate of interest in proportion to the probable return. Now, this would be correct reasoning, if the tenant had no choice but either to accept of the proprietor's money or allow his land to remain unimproved. But as the tenant has the power of doing the work himself, it is evident that the rate of interest ought to depend altogether upon the amount of outlay and the number of years he has to be repaid." [*Q. Journal of Agriculture.*]

IN-AND-IN-BREEDING. See Breeding.

INCISORS. See Teeth.

INCLINED PLANE. The inclined plane is one of the three mechanical powers, or simple machines, formed—as its name imports—by a plane surface, supposed to be perfectly hard and inflexible, and which is always inclined obliquely to the weight or resistance to be overcome, or in any position whatever except parallel or perpendicular to the horizon. The wedge is a modification of this machine, being formed of two inclined planes placed base to base. The screw is another modification, being, in fact, merely an inclined plane wound round a cylinder. This machine enables us to raise a given weight along the inclined surface to a given elevation, with less expense of force than would be required to raise it perpendicularly to the same elevation. This perpendicular height is called the *elevation* or *height* of the plane; and the two lines enclosing the angle which it subtends, are called the *base* and the *length* of the plane.

The inclined plane is a mechanical power of frequent, nay, almost constant application, in cases almost too numerous to be recited. Thus we take advantage of natural slopes to raise bodies upon them, with powers of less intensity than they would require if raised vertically. We lift weights on wheel-carriages by temporary inclined planes, formed of parts, either fixed or moveable, with which they are furnished. In raising weights from cellars, or from one story of a building to another, we convert the stairs into inclined planes, by laying skirts upon them. In all these cases we save friction, by making the body roll instead of sliding. We may also combine this mechanical power, in the case of rolling bodies, with a modification of the moveable pulley: thus, when a barrel is to be raised from a cellar, after laying skirts upon the steps, and thus converting them into an inclined plane, we take a couple of ropes, and, making them fast at the top of the plane, pass them around the barrel, and bring them back again to the top of the plane: a force applied to these ropes causes the barrel to revolve like a roller, and the intensity of the power, in addition to the gain it acquires from the plane, is doubled by the action of this temporary pulley. Inclined planes are also frequently constructed expressly for the purpose of enabling a power to counterbalance a weight of greater intensity: thus in saw-mills, the logs are drawn to the place where they are to be sawn, upon a fixed inclined plane. This principle has also been applied in the cases of roads, railways, and canals. In Morton's marine railway, vessels of great size are drawn from the water upon an inclined plane, by a power exerted through the intervention of modifications and combinations of the wheel and axle.

INARCHING. See Grafting.

INCLOSURE. See Enclosure.

INCUBATION. The developing and maturing of an oviparous fœtus by the steady application of a proper degree of heat; or, in more popular language, the hatching of a young animal from an egg. Oviparous animals are distinguished from viviparous ones by bringing forth their young through the medium of eggs, —unattached by any placenta to the parietes of the uterus or of the oviduct, but separated from it by its most external envelope, and provided with a special aliment, which is enclosed in a sac attached to their intestinal canal. Some oviparous animals hatch their eggs in a state of attachment to their own bodies, and previous to separation from it,—either within it, or on its surface; and these are regarded by many naturalists as a middle class between the true ovipara and the true vivipara, and called ovo-viviparous. The cartilaginous fishes, for example, such as the shark and the skate, hatch their eggs within the body, and expel their young fully formed; the crab and the lobster tribes hatch their eggs beneath the caudal plates of their body; and some species of reptiles, as the pipa, hatch their eggs in cells or agglutinated attachments on the surface of their body. All the true ovipara, however, expel their eggs from their bodies, and either leave them to be hatched by entirely extraneous means, or hatch them with their own heat in a state of complete separation; and, in the great order of vertebrated animals, or irrespective of classes and groups in the lower orders, they comprise all birds, and the great majority of reptiles and of fishes. Some, as most birds, hatch their eggs by sitting on them; some, as the turtle, the crocodile, and many serpents, leave them to be hatched by exposure to the heat of the sun; and some, as the osseous fishes, leave them to be fecundated and hatched in the water. The period of incubation widely differs in different species; and, in the case of birds, it may, in a general view, be regarded as somewhat proportionate to the size of the animal.

Incubation is interesting to our readers chiefly in connexion with the breeding of poultry; and four great topics involved in it specially challenge their attention,—the chemical constitution and chemical transmutations of a bird's egg, the organic changes which take place within the egg during the progress of hatching, the proper management of poultry in all matters connected with their breeding in the poultry-yard, and the most successful methods of hatching fowls' eggs, on a large scale, by means of artificial heat. We have discussed the first of these topics in the article EGG, and must postpone the discussion of the third to the article POULTRY: and we shall occupy the sequel of the present article with a notice of the second in the words of Dr. Burns of Glasgow, and with an abridgment of a long and able paper on the fourth in the Quarterly Journal of Agriculture.

"In the eggs of fowls, we observe the following circumstances. Upon removing the porous shell, we find the albumen enclosed in a membrane, consisting of two layers, and called sacciform by Leviellé. These are separated from each other at the large end of the shell, so as to form a small sac, called the folliculus aeris. The albumen is divided into three strata; the first, or cortical, is most liquid; the second or middle, is more abundant, and thicker than the first, but less so than the third or central. The middle and central strata are enclosed in a delicate membrane, called leucilyme by Leviellé, which separates them from the cortical. Within the albumen we have the vitellus or yolk, which is enclosed in a vascular membrane, called chlorilyme, or membrana vitelli, which again is enveloped by a membrane common to it and the intestines of the chick, called entro-chlorilyme. To each end of the vitellus, we have connected a portion of the central albumen, called chalaza; and in each of these a membranous substance is discovered, attached to the membrane of the vitellus, and a vascular structure, which can absorb the albumen into the vitellus, to contribute to the nutrition of the chick. Upon the vitellus, we observe the cicatricula, or small sac, called by Harvey the eye of the egg, and which was supposed to contain the fœtus, the rudiments of which are allowed by Malpighi, Haller, and Spallanzani, to be pre-existent to fecundation. This cicatricula was considered as analogous to the amnion, and supposed to contain a transparent fluid, called by Harvey colliquamentum candidum, or liquor amnii. More modern observations ascertain that the embryo is not formed in the cicatricula, but very near it on the vitellus, and that the amnion enclosing it can at first scarcely be distinguished from the embryo. The cacitricula soon disappears. Harvey's account must therefore be transferred to the amnion. During incubation, the vitellus becomes specifically lighter than the albumen, and rises towards the folliculus aeris. Two arteries and two veins go from the meseraic and hypogastric vessels of the fœtus, to the membrane of the yolk, and are supposed to absorb the vitellus, which therefore is carried to the vena portæ of the chick, and nourishes the fœtus. There is also a connexion betwixt the intestines and the vitelline membrane, by means of a ligamentous substance, which was supposed by Haller and Vicq. D'Azyr to be a tube, and called vitello-intestinal canal, for it is said that air has been passed through it. It was supposed to absorb the yolk, by many villi on the inner surface of the vitelline membrane; but these are said by Leviellé not to be vessels, but soft lamellated plates. At the end of the second day, red blood is observed on the membrana vitelli. A series of dots are formed, which are converted first into grooves, and then into vessels, which go to the fœtus. This appearance has been called figura venosa, and the marginal vessel, vena terminalis. The vitello intestinal ligament, and these vessels, form an umbilical cord. But besides these, we find, after the fourth day, a vascular membrane at the umbilicus, called membrana umbilicalis, which rapidly increases, and comes presently to cover the inner surface of the membrane of the shell. It is the chorion, and has numerous vessels ramifying on it, like the chorion of the sow, and connected in like manner with the fœtus. The blood of the umbilical artery is dark coloured, that of the vein bright. As incubation advances, the amnion enlarges, and comes in contact every where with the chorion. The albumen is all consumed, being taken into the vitellus, which is in a great measure absorbed; and what remains is taken, together with the sac, into the abdomen of the chick, and the parietes close over it. On the 21st day, the chick breaks the shell and escapes. By increasing or diminishing the temperature within a certain extent, the process may be somewhat accelerated or retarded. The eggs of large birds require a longer time to be hatched; those of the ostrich, for example, take six weeks. Hence it appears, that the vitellus and albumen contribute to the increment of the fœtus, whilst the exterior membranes act as lungs, the air being transmitted through the pores of the shell.

"Sir Everard Home has lately investigated more minutely, by means of the microscope, the structure of the egg. The yolk is enclosed in two layers of membrane, the outermost very thin and delicate; the internal one, on the contrary, thick and spongy, with a small aperture, or deficiency, at one spot. Here the gelatinous molecule, from which the embryo is to be formed, is found placed on the surface of the yolk. It is not quite so large as the opening in the membrane, and, therefore, seems to be surrounded by a margin, or an areola. In its passage along the oviduct, the yolk comes to be surrounded by the albumen, which presently is covered with a very fine membrane. During this descent are also formed the chalazes, which terminate in that double membrane which is added when the egg has reached the lower end of the oviduct, and which is distinct from, and exterior to the fine membrane already noticed. In four hours after the commencement of the incubation, the outer edge of the areola had become enlarged, and that part next the molecule darker. One end of the molecule appeared like a white line, which is the rudiment of the embryo. In eight hours, the white line had extended, and rudiments of the brain and spinal marrow could be discerned, surrounded by a membrane which afterwards becomes the amnion. The areola had extended, and the surface beyond the line which had formed its boundary had acquired the consistence of a membrane, and was circumscribed by a distinct line. This he calls the outer areola. In thirty-six hours, a vesicle had begun to protrude under the inner areola, apparently at the termination of the spinal marrow. In sixty hours, auricles and ventricles were seen, the former filled with red blood; a trunk from the left ventricle gives off two large vessels which send branches over the whole areolar membrane. The vesicle somewhat enlarged. In three days, the vesicle, still more enlarged, had forced its way through the external covering of the yolk, whereby a part of the albumen was admitted to mix with the yolk. In four days, the vesicle was still larger, and its vessels contained red blood. On the fifth, it was of great size, very vascular, and its cavity contained a fluid. On the sixth, it had expanded like a double nightcap, over the yolk, and its coverings were beginning to enclose the embryo. This vesicle, Sir Everard, in another place, compares to the bag which, in the human subject, and in quadrupeds, is to become the urinary bladder. This increases with such rapidity that it bursts the amnion, and the arteries lying on its two sides are carried directly to the chorion, and there the placenta is formed in the empty space between the two edges of the chorion."

The Egyptians originated at a very remote period, and have continued down to the present day, the practice of artificial incubation, in a manner which excites wonder and admiration. They no doubt derived the first suggestion for their 'mamals,' or hatching-ovens—which the enthusiastic Reaumur has pronounced to be nobler monuments than their towering pyramids—from observing the simple operation of Nature in developing life in the ostrich's egg, when laid in the warm sand, without the heat of the parent bird. They perceived that a certain degree of heat only was required for the development of the embryo, and therefore conjectured, that any warmth, precisely the same in power and continuance, would produce the same effect. Their 'mamals' are built of brick, and about 9 feet in height, with a gallery from one end to the other, forming the entrance to the oven, to afford accommodation for keeping the eggs at the proper temperature, and are heated by fires; but the precise mode of regulating them is not made known. These ovens are capable of hatching 100,000,000 eggs annually; and the contractor engages to give only two chickens for every three eggs, receiving for his perquisite any surplus number which he may produce: and he practises his art only during the months of autumn.

A subject of such vast importance in the production of human subsistence, was not indifferent to the Greeks and Romans in their days of science and refinement, who, unable to obtain the necessary information from the Egyptian practitioners, tried the agency of hot-beds, and failed. The same attempt has been often tried, and with similar ill success, for this reason, that it was not in accordance with that of nature; and though it might answer fully in such a climate as that of Egypt, which undergoes so few atmospheric changes during the autumnal months, it is impracticable in the comparatively cold and very variable temperature of any European climate.

Other means than those of the hot-beds were subsequently attempted, and with more favourable results. But for a long period, Europe being madly involved in the crusades and other pursuits opposed to the quiet and useful employments of science, the hatching of eggs was little thought of there; but, on the revival of science in Europe, the art of artificial hatching was again tried successively in Malta, Italy, Sicily, and France. Kings and princes contrived to obtain the secret, and obtained skilful superintendents from the Delta; but the results were not sufficiently favourable to excite individual speculation. It was more the harmless and pleasing amusement of crowned heads, who could afford to pay for it, than the remunerative occupation of private persons labouring for their maintenance. Men of science, however, paid attention to it, and the Chinese mode was introduced into Portugal. This practice was to put the eggs into fine sand, to cover them with a mat, and place them on a furnace heated with coal.

French ingenuity was stimulated. Olivier de Serres gives a description of a small, portable, metal oven, in which the eggs were intermingled with feathers heated by lamps around. But he found this oven more amusing than profitable; for the chickens were far more delicate and subject to disease, than those brought forth in the ordinary way. At length, models of the Egyptian mamals were brought into France, and the celebrated physician Reaumur, who invented the thermometer which bears his name, entered into the subject of artificial incubation with great energy; but, being unfortunately misled by the representations of travellers, he mistook their blunders for defects in the art itself. Conceiving it was to the atmospheric temperature of Egypt that the success of the practice there was entirely attributable, and that the climate of France was too unfavourable for the purpose, he sought out another system altogether, and proposed other contrivances. It is useless to detail all his experiments, as they proved unsuccessful. In some cases, the hot-bed *dressed* the egg for eating, instead of bringing forth chickens; and in another instance, in which he constructed a cavity or oven (heated by the hot-bed) for the eggs, instead of plunging them into the dung, the life was developed, and some chickens were formed, and even feathered, but the eggs putrefied about the eighth or tenth day.

Chopineau, the author of 'L'Homme rival de la Nature,' came nearer to the true principle on which the Egyptian practice has been conducted; and if circumstances had favoured him, he would have probably succeeded better than his celebrated experimental predecessor. His hatching-house, constructed to contain 8,000 eggs, was contrived with great ingenuity. It was a round structure, in the arched top of which were four triangular windows, opening with cords and pulleys. The air was admitted through four pipes at opposite points, opening and closing from the outside, and the stove for heating warm water, by which the eggs were supplied with warmth through a funnel, was placed underneath. The warmth derived in this way was more uniform than had been imparted by any previous mode. It was cooled in a moment by the admission of the external air through the windows and the pipes communicating with the shelves on which the eggs were ranged. The heat was retained in the lower range, where it had the greatest tendency to coolness by the thick walls of the structure, and the wool with which they were lined; and to correct the effects of dryness, steam was introduced with an hygrometrical regulator, to render the exhalation similar to that of a sitting hen.

Then succeeded Dubois' simple plan of a cabinet 10 feet long and 6 wide, with a low floor. The floor was covered with carpet, and the windows consisted of 4 large glass panes. In the middle of this machine a stove was placed, with large balls of clay on the top to retain the heat, and two pounds of charcoal every six hours was a sufficient supply of fuel for heating it. The eggs were deposited in flat osier frames holding 300 each, and laid on iron rods radiating (like the spokes of a wheel) round the stove, and attached to hooks in the ceiling. On each basket was a label, containing the date when the incubation of that particular one commenced. The object of having the cords was to elevate the baskets farther above the stove, or to change their relative positions when a diminution of heat was necessary, which Dubois found to be the case in this machine about the 12th or 13th day.

Bonnemaine endeavoured to improve upon all these contrivances; and he framed, in consequence, a machine, more complicated, but more easily regulated, than any of the others. But it is quite unnecessary to give any exact description of it. The advantages which it is said to have possessed are, 1st, The preservation of uniform heat; 2d, Moisture like that communicated by the natural mother; 3d, The ready application of this dampness to the surface of each egg, so as to influence the embryo within; 4th, The avoidance of such evaporation of the internal fluid, as would render difficult the evolution of the chick from the shell, which is always the case when the white, from any cause, becomes dry and gluey.

Even in the most successful of all these instances of French ingenuity and perseverance, the artificial method has not succeeded in a degree commensurate with the expense and difficulty of producing chickens, and still less with that of the cost of rearing them. In Egypt, the climate does part of the work in the first respect,—the development of life, and more than half in the rearing of the birds. The women, who receive hundreds of chickens in exchange for their eggs, take them to the flat roofs of their houses, or detached yards enclosed with mud walls, four or five feet high, and with fine earth or sand on the floor, where they watch them during the day from the attack of birds of prey, feeding them well with rice and millet. At night, the pullets are locked up in cages made of palm tree branches, lined with thick cloth, and containing several chambers, until they are a month old, when they are transferred to the fowl-yard. In France, where the climate is far better than ours for the purpose of rearing poultry, the difficulty of rearing has been considerable, that of producing comparatively less so. Reaumur calculated on having 96 chicks from 300 eggs; Bonnemaine had nearly as many chicks as eggs. In the natural process of hatching, half is considered a fair average production, from the various accidents which occur both to the eggs and the chickens in the first fortnight; but the mortality among those artificially reared has been much greater, from the influences of climate. The French experimentalists took great pains with the rearing of their chickens. They kept them in the hatching place for some days, in a high temperature; then they formed an artificial mother, a box or cage lined with lamb's wool, and calculated to afford them, when at rest, protection and warmth similar to that of the maternal wings. Chambers, warmed by stoves, were also provided for them; and Bonnemaine took the trouble of constructing rooms, warmed by hot water introduced through pipes, besides arranging flannel at the ends, under which they nestled to warm their backs, and which, like stepmothers in general, were, we suspect, but sorry substitutes for the true parent.

The failure of so many scientific naturalists would lead us to abandon the expectation of rendering practically useful a system, which appears more suited to amuse the minds of the curious than to benefit mankind, especially where an abundance of poultry may be reared by natural means. We do not, however, by any means, despair of seeing perfected a mode of artificial hatching, which, without the extreme labour and assiduity required in all the trials which have been hitherto made, may attain the desired end.

Mr. Moubray, one of the most practical writers on the general subject of poultry, who tried the process of incubation by the oriental method of fire, and who had 35 chickens from 45 eggs, states, that, if there were an adequate motive, the artificial process might be conducted here with sufficient success, and to the immense multiplication of domestic fowls of every description, an adequate expenditure in houses and attendants being presupposed. Now, we conceive that there is an adequate motive for prosecuting the experiment,—that of supplying an abundant, and therefore a cheap, supply of a most delicate and nutritious food, which, from the extravagant prices required for fowls, precludes, in England, all but the very opulent from having them at their tables.

Taking the general average as to the broods of chickens—and to the gallinaceous tribe we confine our present observations—it is probable that not more than one-half of the chickens hatched in the ordinary way are reared for the table. Some hens break their eggs in sitting down too heavily, in changing their positions; some abandon them after a few days; some again sit so unsteadily as to addle the eggs by the alternations of heat and cold; others destroy the chicks in the birth from too great eagerness to see them out of the shells; a few have been known to eat their eggs; some smother the chickens accidentally on their coming out of their shells, and often trample them to death when scraping up food for them, or flying into a passion. Then there are risks from the hawks, foxes, rats, the changes of weather, and various casualties. If the rearing of chickens obtained by artificial hatching in large numbers can be accomplished with certainty and precision, the primary difficulty producing them artificially, and in vast numbers, is not by any means of a very formidable nature. To this conclusion we are led from having observed the system of artificial heating pursued in London by Mr. Bucknell, who exhibited the entire process, and chickens of different ages and in perfect health, in little compartments of the large room in Pall Mall, where the entire system might be seen in constant operation. This appears to be a far more certain, and apparently an easier mode of producing birds artificially, than any hitherto in operation. The mode of regulating the heat is under perfect control, and though there must be numerous failures from the same causes which would apply in the natural way, such as want of impregnation in the eggs, or of vitality from staleness or ill health in the parent, which causes the embryo, after partial development, to fail before the full term, a considerable number come forth in a perfect state, and live, and fatten, and die in due course for the benefit of omnivorous man. See the article Eccaleobion.

"The Eccaleobion, or life-giving machine," says Mr. Bucknell, "forms, to outward appearance, an oblong square wooden box, about 9 feet in length, 3 feet in breadth, and 3½ feet in height, covered, excepting the doors, with cloth. It stands upon a table, and is entirely disconnected from the walls against which it is placed. Its efficient action and regulative power are enclosed within. It is divided into 8 compartments, or divisions, in which the eggs are deposited, spread promiscuously upon the floor of each division. The eggs lie uncovered, neither wrapt in flannel, nor immersed in sand, as has usually been done, in order that they might retain their warmth when exposed to cold, or resist the effects of too great heat. Each egg has the power of generating heat, as the bird within it advances to maturity; consequently a very successful issue from a large number of eggs can be expected only when such quantity is subjected to an uniform action of the machine, regulated according to the degree of heat engendered by the birds. The warmth imparted is uniform and continued. A flush of fresh cool air passing over them each day, for a short time, is considered beneficial."

The chicks in the Eccaleobion may be seen coming forth from the shell every day in the week, full of life and energy, and in different stages of growth. But to carry the principle into any practical extent of national importance, the scale should be much increased, and due provision made for rearing and fattening the pullets. This is apparently the only serious difficulty. Artificial mothers, in Mr. Bucknell's opinion, are useless where large numbers exist; the chickens are crushed by each other, and the purpose at best is but imperfectly answered, as proper temperature in large and convenient compartments until they are strong enough for removal is found sufficient. Nor do they seem to require any instruction from the mother; instinct quickly teaches them all they require, or if example be necessary for them, other chickens supply it. These often at the age of two months take pleasure in brooding the younger birds; and as Mr. Bucknell remarks, "Though probably it is the pleasurable sensation derived from the warmth communicated by the young birds nestling under them, which induces them to do it, it is nevertheless a striking and highly interesting picture to witness these mimic mothers acting the part of foster parents with so much apparent satisfaction, yet with the awkwardness with which a girl in similar circumstances fondles her doll."

Gallinaceous fowls are uncommonly productive, and the number of eggs which, according to the bountiful provision of Providence, is produced by the *domesticated* kinds, which (unlike those in a state of nature) lay considerably more than they can hatch, is an assurance that the supply of fertile eggs for artificial incubation to any extent might be obtained. Some instances of the fecundity of hens are before us: produce of three hens (two of them more correctly pullets), from the 6th of May to the 6th of November, 343 eggs, produce of three Poland pullets, hatched in the preceding June, from December 1, 1835 to December 1, 1836, 524 eggs. An illimitable supply of fertile eggs might be raised without difficulty by ourselves, and for the mere purpose of egg-eating. The continent, which supplies more than seventy millions a-year, would still be a sure resource for the general markets, if they cannot be supplied at home.

Buildings, both open and enclosed, in dry and warm situations, and admitting of healthful exercise, arranged on a sufficient scale, and constructed for artificial warmth, are the principal *desiderata;* the temperature in each should be accommodated to the respective ages of the birds until they can be gradually habituated to the external atmosphere, if they be designed for mature life, and the internal arrangement of these buildings should be suited to the habits of the different species of birds to be reared, whether to turkeys, geese, ducks, chickens, pheasants, or partridge, and each species separated from the others, with sufficient space for exercise. Mr. Bucknell states that heated apartments would not answer for the young birds, which would die from cold and cramp when afterwards turned out of doors. He objects also to steam or hot water-pipes, from the irregularity of temperature which they occasion, while he asserts that the application of the principle of the Eccaleobion machinery to rearing will insure health. Superintendence also would be very easily discharged; one person could as easily manage thousands of birds, properly classed, as a single brood on a cottage floor, where there is constant need of care, and anxiety to guard from injuries; and we are inclined to think that there is much more loss of life and health from atmospheric variations, and their consequent influences, than would arise on the ground of constitutional delicacy in birds reared in artificial warmth.

The concluding observations of Mr. Bucknell fairly express the opinion which we ourselves are disposed to hold. "All circumstances considered, it would be found that a considerable capital would be required, and to be judiciously expended, before artificial incubation and rearing could be placed upon a basis sufficiently extensive to render it profitable, and which can only be done upon the principle of producing quantity, so that the necessary expenses shall be divided over a large number. This accomplished, the reward would be highly lucrative."

INDIAN BAY. See LAUREL.

INDIAN CORN. See MAIZE.

INDIAN CRESS,—botanically *Tropæolum.* A genus of trailing and climbing herbaceous, ornamental plants, constituting the natural order Tropæoleæ or Tropæolaceæ. This order is nearly allied to the geranium order; but is distinguished from it by the separatedness of its stamens, by a difference in number between its stamens and its petals, by the axillary position of its flowers, and by the fleshiness and indehiscence of its fruit. All its species have fleshy stems, succulent leaves, and elegant, solitary, axillary flowers; most possess, in a very sensible or even eminent degree, the peculiar antiscorbutic acridity which distinguishes many of the cruciferæ, particularly the mustards and the cresses; all are more or less esteemed as showy and popular flowering-plants; and some possess considerable culinary value, in giving their fruit for pickles, their leaves for garnish, or their fleshy roots as esculents.

The common or greater Indian cress, often popularly called nasturtium or the greater nasturtium, *Tropæolum majus,* is a native of Peru, and was introduced to Britain in the latter part of the 17th century. Its root is annual in Britain when treated in the open ground, but perennial when treated in the greenhouse; its stems usually attain a length of 6 or 7 feet, and trail along the ground when unsupported, but readily climb and form a kind of festoon when duly assisted; its leaves have a greyish-green or greenish-grey colour, and have their footstalks inserted on their centre, and are poised upon them with the appearance of miniature bucklers; its flowers stand on very long slender footstalks, and have each two large and rounded upper petals and three narrow under petals, with their spurs joined together and prolonged into an awled projection, and have great diversities of streaked and variegated ground colour, from pale yellow through rich orange to bloody and almost blackish brown, and usually bloom through a long succession from June till October; and its fruit is roundish and furrowed, and is divided into three lobes, each containing one streaked seed. The leaves and flowers are used in salads and for garnishing; and the fruit has been long and extensively used as a favourite pickle. This plant thrives in almost any soil, but is most luxuriant and productive in light fresh loam. The seeds may either be deposited in a drill two inches deep, or dibbled into thoroughly prepared soil, at distances of 2 or 2½ inches between every two seeds; they may be sown at any time between the end of February and the middle of May; and they must either be deposited along the base of a hedge, wall, or paling, or provided with short sticks similar to those for pease in an open compartment. The young stems require considerable attention, or at least repeated manual assistance, to enable them to commence vigorous climbing; but after being fairly established in a vertical direction, they climb without further help. The plants, in order to be luxuriant and productive, ought to be artificially watered during droughts. Fruit for pickling must be gathered just when at full size, and while thoroughly green and fleshy; and fruit intended for seed must stand till quite ripe, and not be stored till hard and winnowed. Promiscuous sowings of this plant, yielding great varieties in the ground colour of the flowers, are amongst the most common of ornamental annuals; and are special and universal favourites with children, and with all cottage florists of little information or unfastidious taste, who prefer glare and brilliance to delicacy and graceful beauty. Yet some of the dark-coloured varieties deserve the attention of somewhat refined florists; and a double-flowered variety, *T. m. flore-pleno*, claims the special care of professional florists, and is kept potted, as a perennial-rooted herbaceous evergreen, among the beauties of the greenhouse.

The smaller Indian cress, *Tropæolum minus*, is also a native of Peru, and was introduced to Britain before the close of the 16th century. It is often popularly confounded with the preceding species, and made to share with it the misnomer of nasturtium; it is regarded even by some botanists as but a variety of that species; and it certainly possesses very close affinity to it in specific characters and habit; but it differs in its stem being only from 12 to 18 inches long, in its leaves being smaller in size and far less lobed, and in its petals being pointed, and not rounded, at their extremity. This species, though quite as esculent as the other, is not in any request in the kitchen-garden; but it is sometimes preferred in the flower-garden for its comparative smallness; and a double-flowered variety of it is cultivated in the greenhouse.

The three-coloured Indian cress, *Tropæolum tricolorum*, is a remarkable and singularly brilliant, perennial-rooted, trellis-trained inhabitant of the greenhouse; and was introduced to Britain from Santiago in 1836; and has, for several years past, been one of the most popular of the show-plants of professional florists. Its stems are not thicker than a good thread; and yet they can be trained out to the enormous length of about an hundred feet; and those of a single plant sometimes thickly enough cover a superficies of trellis amounting to 36 square feet. The leaves are delicate, and combine in character with the stems to give a fine wire trellis a wonderfully graceful and gentle clothing. The flowers have a predominantly brilliant scarlet colour, with a black band round the larger end, and a bright yellow lip; and they bloom in such profusion as to adorn every part of the trellis with abundant sprinklings of gems; and each is shaped almost like a miniature horn, and is airily poised by the middle upon its long, slender, curved, and tendril-looking flower-stalk. "Almost every gardener who has pretended to exhibit plants," said the Horticultural Magazine in 1845, "has made a point of trying his skill on the growth of this fine and delicate subject; and scarcely an exhibition has taken place without their being many of them, trained in many ways, shown as specimens or placed in choice collections. There are many seedling varieties of this species which run larger or smaller, some paler, but none brighter. One of the best of these is called Jarrattii, but it is simply a fine Tricolor, exhibiting no difference but the size, and that soon lost in bad hands." This plant can be raised from either seeds, cuttings, or bulbs, but does best from the last. These are imported of the size of walnuts; and should be planted just under the surface of the soil, in pots of the size of small forty-eights or large sixties, and afterwards shifted into twenty-fours.

The chief of the other introduced species of Indian cress, are *Tropæolum aduncum*, an orange and yellow flowered trailing annual, of three-feet length of stem; *T. pinnatum*, a yellow-flowered, greenhouse, evergreen climber, of two-feet length of stem; *T. peregrinum*, an orange-flowered, greenhouse, evergreen trailer, of two-feet length of stem; *T. pentaphyllum*, a yellow and orange flowered, greenhouse, evergreen twiner, of three-feet length of stem; *T. polyphyllum*, an orange-flowered, greenhouse climber, of three-feet length of stem; *T. brachyceras*, a yellow-flowered, and tuberous-rooted perennial from Buenos Ayres; and *T. tuberosum*, a yellow and red flowered, tuberous-rooted frame plant, of three-feet length of stem, cultivated for economical purposes in Peru. A considerable number of hybrids and varieties, also, occur in the public nurseries. But the main floral fame of the genus is at present concentrated in T. tricolorum.

INDIAN DOOB-GRASS. See Cynodon.

INDIAN FIG. See Opuntia.

INDIAN HAWTHORN,—botanically *Raphiolepis*. A genus of ornamental, white-flowered, evergreen, Chinese shrubs, of the rosaceous order. Six species, the Indian, the red, the brown-stamened, the broad-leaved, the smooth, and the willow-leaved, have been introduced to Britain; and all these are from 3 to 5 feet high, and bloom from early spring till autumn, and require greenhouse treatment, and succeed best in peaty loam, and are propagated from cuttings.

INDIAN LOTUS, See Water-Lily.

INDIAN MADDER,—botanically *Hedyotis*. A genus of exotic, white-flowered, herbaceous plants, of the madder family. Two perennial-rooted species, and four or five annuals, all more or less tender, have been introduced to Britain; but they possess little interest, except for being the type of a division or tribe of Rubiaceæ, comprising the beautiful bouvardias and nine other genera. The botanical name hedyotis signifies 'sweet ear,' and alludes to the ear-like shape of the leaves.

INDIAN MILLET,—botanically *Sorghum*. A genus of exotic cereal grasses, of the villiflorous or sugar-cane family. Two perennials, one biennial, and seven or eight annuals, have been introduced to Britain from India, Persia, Syria, Africa, and Australia; and two or three additional species are known. The flowers of a single plant are variously male, female, and hermaphrodite; the panicled glume is close, two-flowered, thick, and gristly; the male glume is stalked and one-flowered; the paleæ of the hermaphrodite are bearded; and the paleæ of the male are beardless.

The common Indian millet, *Sorghum vulgare*, is diffused through Hindostan, Arabia, the West Indies, and many other countries; and was introduced to Britain from India before the close of the 16th century. It is called dara or durra in Arabia, Negro corn or Guinea corn in the West Indies, and nagara in the north of China. Its root is annual; its culm is from 4 to 6 feet high; its leaves are long, and from one inch to two inches broad; its panicle is contracted and oblong; its peduncles or seed-stalks are hard and rigid, and are often used for small brooms, and imported for that purpose into Britain, and occasion the plant to be sometimes called broom-corn; its flowers are inversely egg-shaped; and its ripe seed is hard, flinty, smooth, shining, brownish-red, irregularly-shaped, and about as large as hemp-seed. This plant, when grown in favourable circumstances of climate, soil, and culture, is said to yield a larger bulk of seed per acre than any other cereal grass whatever, not even excepting maize; but it requires a warmer climate than even the common millet, *Panicum miliaceum;* and though it sometimes flowers in Britain, it never ripens seed in this country. It is cultivated in most countries within the tropics, and in many of the warm districts of the northern temperate zone, particularly some parts of North America, and not a few parts of Southern Europe, even as far north as Germany.

The two-coloured or whitish Indian millet, *Sorghum bicolor*, was introduced to Britain about 115 years ago from Persia. Its roots are annual; its culms are 3 or 4 feet high; its glumes are smaller, softer, and less adhesive than those of the common species; and its seeds are larger, rounder, and less flinty, and have a whitish colour, tinged with pink or light brown. This species is also cultivated in tropical countries; but it is less accommodating to the climate of the temperate zone, and takes a longer time to ripen, than the common species.

The avena-like Indian millet, *Sorghum avenaceum*, called by some botanists *Holcus avenaceus*, is an annual indigen of the Cape of Good Hope, and was introduced thence to Britain about 30 years ago. It has a height of 3 or 4 feet, and is comparatively late in flowering; and it is cultivated, as a cereal grass, in the South of Africa.—The other species cultivated in their native regions or in other warm countries, and introduced to the botanical collections of Britain, are the drooping, an annual of 3 or 4 feet in height,—the black, an annual of from 4 to 6 feet in height,—the sugared, a biennial, from India, of 6 or 8 feet in height,—the red-seeded, an annual, from Africa, of 3 or 4 feet in height,—and the Caffres', an annual, from the Cape of Good Hope, of 3 or 4 feet in height.

INDIAN PINK,—botanically *Dianthus Sinensis*. A beautiful, half-hardy, biennial plant, of the carnation genus. It is a native of China, and was introduced thence to Britain in the early part of last century, and was, for a long time, commonly called China pink. Its stem branches out in every direction, and has a somewhat procumbent or trailing habit, and seldom attains a height of more than 8 or 9 inches; its branches grow erect, and terminate each in one flower; and its flowers have a great diversity of brilliant colours, particularly tints of red and white, and begin to bloom in July, and continue in succession till arrested by the frost of winter. Some double-flowered varieties display exquisite richness of colouring, and are as full of petals as the double garden pink. This plant is treated, in all respects, like any ordinary half-hardy annual; and is peculiarly suitable to be sown in beds; but, though commonly regarded as an annual, and readily blooming in the first year, its roots will continue two years in the dry ground. It every where deserves to rank among the very best of the annuals of the open border.

INDIAN SHOT. See Canna.

INDIAN TOBACCO,—botanically *Cannabis Indica*. An urticaceous annual plant, of the hemp genus. It has a height of about 20 inches, and does not bloom till autumn. It occurs both wild and cultivated in India; and was introduced thence to Britain about 47 years ago.

INDIGENOUS PLANTS. Plants in a wild or native state. The indigens or indigenous plants of Britain, for example, are such as grow naturally in Britain, or are not known to have been artificially introduced from other lands.

INDIGESTION. The fermentation or imperfect reduction of food in the stomach. A common, bad, acute kind of it in cattle is discussed in the article Hoove. A similar kind of it in horses, though very infrequent compared to that in cattle, is popularly called stomach staggers; and consists simply in mechanical distension from the fermenting evolution of gas; and must be combated, in a manner similar to hoove, by dislodging the indigested mass of food, by neutralizing the gas evolved from it, and by reducing any accompanying symptomatic effects. The chief means of dislodging the food is Read's stomach pump; and the most effectual means of neutralizing the gas is chloruret of potash.

A chronic form of indigestion, or a kind of dyspepsy, sometimes attacks horses, and greatly impairs their strength and reduces their condition. A horse affected by it either has little appetite or a very irregular one; he passes a large portion of the materials of his food in an unassimilated condition, or not in a very different one from that in which they were eaten; and, in the advanced stages of his illness, he has a dry and staring coat; and exhibits the peculiar appearance of being hide-bound. See the article Hide-Bound. The immediate causes of his symptoms are some morbid change in the stomach, some imperfection in its secretions, or the presence in it of some improper and disturbing matter; and the originating causes may be a filthy and ill-ventilated stable, the use of musty hay or corn, the administration of spices and cordials, the heating of the body with clothing, the presence of intestinal worms, or any one or more of an hundred other unhealthy influences. The cure, like that of dyspepsy in the human subject, is determined by the nature of the cause, and must be such as to bring the digestive system under a totally different set of influences from those which have accompanied the disease. If worms be present, anthelmintics must be given; if the organic power of the stomach be diminished, tonics must be given; if good air, proper exercise, and sufficient grooming have been a-wanting, these requisites of sound health must be supplied; and, in any event, good, restorative food, of a different kind from what the animal has been recently accustomed to, must be supplied, — particularly succulent food in spring, and abundance of nourishing food in autumn.

A kind of dyspepsy also attacks sheep,—particularly sheep which have been excessively fatigued by overdriving, or sheep which have been half starved during some part of winter, or ewes which have lambed at a very early period of the year before the season of vernal grass, or ewes which have had twins, and have afterwards fed on insufficient pasture. Dyspeptic sheep eat carelessly and in insufficient quantity; they wander much on the pasture, and seem unhappy, and do not steadily graze, but only nibble at the grass in scattered pickings; and, in an advanced stage of their disease, they become lank in the belly, bowed in the back, and emaciated in general appearance. Should they not be very far gone, they may be somewhat easily though but slowly recovered, by means of a purging drink, a course of tonics, and removal to thoroughly good pasture.

INDIGO (BASTARD). See AMORPHA.

INDIGOFERA. See INDIGO.

INDIRECT TAXES. Those taxes which fall in reality on other persons than the immediate subjects of them. They are therefore taxes upon those who finally pay them, and not upon those upon whom they are directly laid. Thus the state exacts custom and excise duties from merchants, upon merchandise, but the consumer, in the price he pays for his articles, refunds this tax to the merchant, so that the last buyer is the one who really pays the tax. There are taxes which appear to be direct, but yet fall indirectly upon others; for instance, the poll tax upon the serfs in Russia. As they are obliged to give every thing, except what they need for their subsistence, to their masters, the latter, of course, obtain so much the less as the poll tax is greater, and thus the tax upon the peasants appears to be an indirect tax upon their masters. Thus almost all direct taxes upon servants are paid by their masters, and therefore a direct tax upon the former is an indirect tax upon the latter.

INFANT, in law. By the English, and generally by the American, and so by the French law, persons come to majority at the age of twenty-one years, until which time they are called in law *infants*, and are under guardianship or tutelage. The laws of some of the states of the American union, however, make a distinction between males and females, the age of eighteen being that of majority in females. Infants cannot, in general, bind themselves by contracts, as they are supposed not to have sufficient discretion for this purpose. But this is their privilege, and their contracts are accordingly held in general not to be void, but only voidable at their election; and they may elect to avoid their contracts during their minority, but they cannot confirm them so as to be bound by them, until their majority. Infants may possess property, but it must be under the management and control of a guardian. They have not the right of citizens as to voting, and discharging other political functions. But in regard to crimes and punishments, and trespasses and private wrongs, their conduct is regulated by the same laws as that of the other members of the community, in case of their being of sufficient age and discretion to understand their duties and obligations. And for this purpose no general limit can be assigned, as some children are much more intelligent than others of the same age; and it will again depend, in some degree, upon the nature of the offence committed, or the wrong done, whether a child of any given age can be considered legally guilty of it, since some offences and wrongs can be more easily understood to be such than others. The law, in general, has a tender regard to youth, and does not permit them to be convicted and punished for offences and trespasses, unless it appears clearly that they have sufficient knowledge and discretion to distinguish them to be such. There are exceptions to the incapacities of minors as to contracting, and these exceptions are made for their benefit. Thus an infant not sufficiently furnished with necessary clothes, food, or instruction, by his parent or guardian, and not being under the immediate superintendence of the parent or guardian, may make a valid contract, in respect to those subjects, and such contract may be enforced against him. Another exception to the general incapacity of infants to contract, relates to the contract of marriage, which, by the law of England and the United States, may be made by a male at the age of fourteen, and by a female at that of twelve. The French code fixes the age for making a valid marriage-contract, in the case of the male, at eighteen, and in that of the female at fifteen. And as the law gives validity to the principal contract, the prevalent doctrine, though subject to some doubt as to the extent of its application, is, that all contracts collateral and incidental to that of marriage, such as making marriage settlements by the husband, and accepting them instead of dower by the wife, are equally binding on both of the parties, being of age to contract marriage, and, accordingly, not subject to be revoked either before or after coming to the age of majority. If, however, one party be under the age at which a contract of marriage may be made, he or she may, on arriving at such age, either ratify or annul any such contract previously made. The courts will appoint guardians to take charge of the property of infants, and, in case of the decease of the father, to take charge of their persons; but, during the life of the father, he has the guardianship and control of the persons of his sons until they are twenty-one years of age, and of his daughters until they are either eighteen or twenty-one. At a certain age, however, that is, twelve or fourteen, the child, in case of the decease of the father, may choose his own guardian, who, being approved by the proper judge, is appointed accordingly.

INFERTILITY OF SEEDS. See AGRICULTURAL SEEDS.

INFERTILITY OF SOILS. See BARREN SOILS.

INFIELD. The enclosed portion of land, adjacent to the farmery, in the old and barbarous system of Scottish husbandry. This portion was contradistinguished from the unenclosed and distant portions,—which, therefore, bore the name of outfield.

INFLAMED VEIN. Violent inflammation of a vein which has been opened by surgical bleeding. This is more frequent in the horse than in man; but it is also more manageable and far less dangerous. It oftenest occurs in the jugular of the horse, partly because that vein is more frequently opened than other veins, and partly because it is more exposed. "In the early stage of the disease, the wound appears a little swelled, a thin ichorous discharge escapes from about the pin, the vein feels hard, and the hardness is continued upwards toward the ear. As the disease increases, the parts enlarge from the inflammation extending into the surrounding cellular membrane, and up into the parotid gland. The lips of the wound become everted, and a portion of lymph is found protruded through the orifice. A quantity of pus or serum escapes from it, or perhaps a copious flow of blood takes place, which becomes alarming by its quantity, and the difficulty of stopping it. In many cases, the first indication of the disease is found to consist in the vein bleeding afresh some few days after the wound has been pinned up, in consequence of the animal having rubbed the pin against the manger; or from the pressure of the collar, in draught, having obstructed the circulation, and, under violent exertion, caused it to break the coagulum by which the wound had been closed. In all cases, the disease is known by the vein feeling hard and swelled,—a symptom which will distinguish it from simple inflammation."

If the case be slight or only commencing, and be attended by but a trivial discharge, the parts may be bathed first with hot water, and next with a solution of one ounce of sulphate of zinc in 16 ounces of water. But if the case be bad, or if a slight case turn worse in spite of the bathings, or especially if there be a copious flow of blood, a piece of sulphate of copper about the size of a pea may be introduced into the wound, or, what is far better, a blunt piece of iron, in a state of brown heat, must be so applied as to excite in the lips of the wound a degree of inflammation just sufficient to produce adhesion, or to form an eschar, and plug up the wound; if a portion of lymph be protruded through the external orifice, a blister must be applied in the course of the vein, from the wound upward; if the protrusion of lymph and the accompanying symptoms be not sufficiently checked, the blistering must be continued; and if the wound still continue open, and make a discharge, a weak solution of sulphate of zinc or of oxymuriate of mercury may be injected into it with a syringe, or simply the blistering may be continued.

INFLAMMÁTION. A morbidly heated and accelerated action of the vascular system of an animal. The old humoral pathologists regarded inflammation as a disease of the blood, and accounted for local inflammatory symptoms on the supposition that the blood became viscid, and could not freely find its way through the finer vessels. But all pathologists of the present day know that blood drawn from an animal labouring under inflammation is more fluid, and remains longer fluid, than that which is taken from the same animal when in health; and the great majority ascribe inflammation to such an increased action of the vascular system as causes the blood to circulate with unusual velocity, and either throws the whole system into derangement, or disturbs and overwhelms some particular parts. Yet though inflammation is properly a state of the blood-vessels, and not a state of the blood itself, the latter becomes altered by it, and loses part of its disposition to coagulate.

General or diffused inflammation assumes the form either of inflammatory fever or of the idiopathic inflammation of some vital or highly important organ; and local inflammation appears in the heat, redness, tension, and pain of parts which are more or less exterior, and more or less open to observation. Acute inflammation attacks the most vascular parts, and is comparatively rapid in progress and easy of control; and chronic inflammation attacks the least vascular parts, such as ligaments, tendons, and bones, and is comparatively slow in progress and difficult of control. Common inflammation involves only the ordinary processes, and is attended with only the ordinary symptoms, of inflammatory action; and specific inflammation, such as rheumatism or rabies, has both processes and symptoms peculiar to itself. Phlegmonous inflammation so attacks the vessels of the skin and membranes as to produce tension, uniform redness, and either suppuration or effusion; and erysipelatous inflammation so attacks these vessels as to occasion little tension and no uniform redness, but to produce first small blisterings and afterwards desquamation.

Inflammation terminates in either resolution, suppuration, effusion, or gangrene. Resolution is such a subsidence of the disease as allows all the affected parts gradually and directly to recover their sound and healthy condition; suppuration is the formation of purulent matter or the producing of an abscess; effusion is either the extravasation of blood or the excessive secretion of serum or coagulable lymph; and gangrene, or mortification, is the irretrievable derangement, the disruption, and the death of the inflamed parts. But suppuration and effusion are very diversified, and often control and modify each other, and sometimes give place either to adhesive phenomena of ordinary inflammatory action, or the peculiar processes and symptoms of special inflammation. Metastasis, or the disappearance of inflammation from one part in consequence of the abduction of it to an adjacent part, might be named as a fifth form in which inflammatory action terminates; but a natural metastasis is comparatively rare, and amounts rather to the spreading or re-excitement of the disease than to the termination of it; and an artificial metastasis draws off the inflammatory action from a more important part to a less important one, and is not, in any sense, a process of the disease itself, but altogether the effect of one of the chief remedial means of combating it.

General inflammation arises from the agencies of heat, cold, miasmata, and deleterious gases, often in so obscure or complicated a manner as to baffle investigation, and comport ill with any well-defined theory; and it arises also from the action of heating and stimulating substances taken into the stomach, and is more or less easily superinduced according to previous vigour of the system and fulness of the blood. The old pathologists ascribed exceedingly much to cold; and the modern ones, in general, ascribe a great deal to sudden and violent alternations of cold and heat. But the proximate cause, in every case, occurs in the relation which exists between the state of the blood-vessels and the circulation of the blood; and it is more readily brought into action in a plethoric body than in a spare one, in a body coolly dieted than in a stimulated one, and in a body unaccustomed to vicissitude of temperature than in a brawny, hardy, weather-beaten one. Local inflammation may arise from the same causes as general inflammation, or may be occasioned by an effort of the system to concentrate diffused inflammatory action in one locality, but more frequently arises either from external chemical stimulants, or from wounds, bruises, abrasions, and other mechanical injuries.

The chief means employed for resolving general inflammation are bleeding, purging, fomenting, poulticing, blistering, and the application of lotions. Bleeding is by far the most important; and requires, in many instances, to be at once early, copious, and repeated. Purging is occasionally of very great importance, and often of at least considerable consequence; yet it is sometimes injurious, and always requires more or less of caution. Fomenting, poulticing, and the use of lotions have reference only to seats and developments of inflammation near the surface; and blistering has reference only to such varieties of it as are likely to be drawn to the surface by metastasis; and these four methods cannot all be employed in any one case, but are more or less incompatible with one another, and must be severally selected and modified in judicious adaptation to the nature of each case. Any local inflammation which arises from a natural effort of the system to throw out an internal disease ought to be coaxed as speedily as possible to a state of suppuration, and then prevented from taking the direction of gangrene; and other local inflammations, whether acute or chronic, ought, by a diversity of methods adapted to their respective seats and peculiarities, to be brought with all possible speed to resolution. Chronic local inflammations, particularly those of the joints and tendons, are the most difficult to manage. "As in these cases the inflammation generally proves more troublesome, and as the pain which it occasions is often so considerable as to produce symptomatic fever, it becomes necessary to employ, without loss of time, the most prompt and efficacious means for its reduction. With this view we excite artificial inflammation in the contiguous skin and cellular membrane, which are parts of far less importance in the animal economy, than joints or tendons, and capable of bearing a considerable degree of inflammation without much inconvenience to the animal. This in the case of the horse is done by means of rowels and blisters; and the inflammation thus excited, will tend in a considerable degree to diminish that which is going on in the more important part. Should we fail in our endeavours to resolve inflammation, it will probably terminate in suppuration; and when it appears that the disease does not abate by the use of rowels and blisters, an assiduous application of fomentations and poultices will expedite the suppurative process, and afford great relief to the animal."

Inflammation of the brain, or phrenitis, sometimes occurs in the horse. Many farriers confound it with staggers; and others call it mad staggers, sleepy staggers, or phrensied fever. The causes of it are obscure and diversified; they comprise metastasis, violent exercise, the excessive play of hot sunshine, and such disturbed conditions of the internal organism as determine a flow of blood to the head; and they sometimes are so complicated with causes of visceral derangement as to baffle the investigations of even the most skilful veterinarian. The phrenitic horse is affected in nearly the same way as the apoplectic one; he is drowsy, stupid, and sleepy; he goes asleep and falls down in the very act of eating; he breathes laboriously; and he has a slow and creeping pulse. But he has less coma and more sensibility than the apoplectic horse; he is more manageable; and he passes up from the earliest to the worst stages of the disease in a far less space of time. He soon becomes frantic; and even though early and promptly bled, may exhibit wild phrenzy and violent convulsion. He is at one time in a state of stupor and exhaustion, and at another time in a state of furor and most terrific excitement; and should he not be cured, he may repeatedly or frequently alternate from the one state to the other till he becomes totally exhausted and dies. Should he acquire more tranquillity of manner than in his first paroxysm, and more softness of pulse than in his first stupor, he will probably recover; but should he become increasingly excited and furious, and grind his teeth, and make a sanious discharge from the nose, he will probably die. The grand remedies are very copious bleeding and prompt and smart purging. The blood-letting may be not a little difficult, but must be dexterously and speedily done at a moment of comparative stupor; and the purging should if practicable be preceded by a cathartic glyster, and may be effected by means of a strong solution of aloes, or a liquid exhibition of croton powder. The horse, even when unconscious, will, in most cases, readily drink water or gruel; and he may promptly enough take up any quantity or repetition of powerful liquid cathartic which may be necessary to purge him.

Inflammation of the liver, or hepatitis, is seldom idiopathic in the horse, yet frequently accompanies great or general abdominal inflammations. It usually arises from excessive exertion; and must be treated in the same manner as enteritis, with the addition of administering active purgatives. It is sometimes attended with diarrhœa; and in that case it must be treated with scanty blood-letting, and with the administration of combined purgatives and opiates.—Hepatitis is more frequent in cattle than in horses; and sometimes has an acute idiopathic form, and sometimes is accompanied with diarrhœa, but more commonly assumes a slow chronic character. The chief causes of it are overdriving, blows, stimulating food, and improper treatment of diseases of the skin. The acute forms of it must be reduced by bleeding, purging, blistering, and somewhat low diet; and the chronic forms must be treated according to their peculiar developments, or similarly to the diseases which they may eventually produce or resemble. "Perhaps," says Youatt, in reference to chronic hepatitis in cattle, "it never assumed any great degree of intensity, or the intense inflammation was palliated, but not removed; and this state may exist for some months or years, not characterised by any decided symptom, and but little interfering with health. Then commences induration, or hardening of a portion of the liver, or of the greater part of it, and accompanied by tubercles, vomicæ, hydatids, and the existence of the fluke-worm in the ducts." See the articles LIVER, HYDATID, FLUKE, and JAUNDICE.

Inflammation of the kidneys, or nephritis, in the horse, is not very common, but has a very serious character, and is ill understood by ordinary farriers. The chief causes of it are exposure to cold, the dripping of rain upon the loins, the bruising action of an awkward rider, the undue use of diuretic medicine, and the prolonged dietetary use of kiln-dried oats or of mow-burnt hay. The early symptoms are similar to those of general fever; and the subsequent ones are straddling asunder of the legs, anxious looking to the flanks, shrinking from a pressure of the loins, frequent, scanty, and difficult urinating, redness or bloodiness of the urine, eventual suppression of the urine in spite of strenuous efforts to evacuate it, and hardness, frequency, and fullness of the pulse, eventually increasing to smallness, oppressedness, and violent rapidity. The farrier may readily distinguish nephritis from inflammation of either the neck of the bladder or the whole body of the bladder, by passing his hand up the rectum; for if the disease be nephritis, he will find the bladder, whether full or empty, to be neither hotter nor more tender than the surrounding parts. The proper remedies are copious bleeding, active purging, and the raising of counter-irritation as near as possible to the seat of the disease by means of a mustard poultice or of hot fomentations. But the administration of diuretics, which some farriers practise, is downright murder; and blistering or counter-irritating by means of turpentine or cantharides is little better,—all these substances having a stimulating action upon the kidneys, and therefore serving, not at all to reduce the disease, but directly and tremendously to aggravate it. Nephritis in cattle is popularly called red-water, and will be noticed in the article RED-WATER.

Inflammation of the bladder, or cystitis, in the horse, may arise from the same causes which produce inflammation in any of the other viscera, but very commonly arises from improper and prolonged use of diuretic medicines. It is more frequent in male horses than in mares. The symptoms are very similar to those of inflammation of the kidneys; but the bladder, when examined by the hand of the farrier passed up the rectum, will be found hot, tender, and wholly or comparatively empty. The proper treatment is the same as for inflammation of the kidneys, except that the mustard poultice must not be applied, and fomentation of the pubes with hot water must be very abundant.—Cystitis is rare in British cattle, and, when it does occur, must be treated in the same way as cystitis in the horse. A remarkable variety of it prevails and works havoc in the south of France, and is generally believed to arise from browsing upon broom.

Inflammation of the neck of the bladder, in the horse, is a more serious affair than inflammation of the bladder itself, and sometimes accompanies it, sometimes occurs alone; and it is characterized, in addition to the symptoms of nephritis or of proper cystitis, by the distension of the bladder, and the loss of power to evacuate it. The same appliances for reducing it must be used, as in the case of the cognate diseases; but if these do not act with sufficient promptitude to restore the lost power of the organ, and induce natural evacuation, artificial means must be employed for drawing off the urine. The passing of the hand up the rectum, and making a gentle pressure upon the bladder, may probably effect evacuation; and when this fails, the catheter must be used in the case of a mare, and may be tried in the case of a male horse; and, as a last resource, the bladder of the male horse must be punctured by passing a trochar up the rectum. An exceedingly copious bleeding sometimes restores the tone of the bladder, and repeated small doses of opium are said by Delabere Blaine sometimes to afford great relief.

Inflammation of the neck of the bladder in cattle arises sometimes from cold, and more frequently from eating the hot and stimulating plants which occur on heathy pastures. It may be recognised by the same symptoms, and must be treated in somewhat the same way, as in the horse. If it proceed to near or immediate risk of rupture of the bladder, its symptoms are aggravated into constant straining of the urinary region, heaving of the flanks, rapidity of the pulse, cessation of rumination, and fits of shivering. A bleeding so copious as almost to produce fainting, may possibly afford relief; a purgative should afterwards be given; and, if the bladder continue distended, mechanical or surgical means of evacuating it must promptly be used.—The frequent and painful urination of the cow near the period of parturition, ought not to be mistaken for inflammation, and does not require any remedial treatment; for it is occasioned simply by irritation of the bladder from the pressure of the fœtus, and will cease when parturition is over.

Inflammation of the womb, hysteritis, or metritis, is generally so complicated with the early stages of puerperal fever as to possess no separate character and require no separate treatment. See the article Puerperal Fever. Hysteritis may also arise from participation in other abdominal inflammations, especially peritonitis and cystitis; and, in every such case, it ought simply to share their treatment. It occasionally attacks mares, and oftener cows, after abortion or difficult parturition, particularly if injudicious or violent artificial aid has been given; but, in such cases as in the preceding, it has only the characters, and requires only the treatment, which are common to ordinary abdominal inflammations.

Inflammation of the larynx, or laryngitis, in the horse, is very frequently accompanied with either catarrh or bronchitis or both. When it occurs alone and in acute form, it may be readily distinguished by auscultation, and must be very promptly treated with copious bleeding, a powerful blister, and an antifebrile, sedative, and aperient exhibition of tartar emetic, foxglove, saltpetre, and aloes. If it have a violent form, and be not wisely, promptly, and vigorously dealt with, it will speedily make sad havoc upon the delicate organism affected by it, and terminate in suffocation. But a chronic form of laryngitis is more common than the acute form, and gives rise to some of the worst coughs with which horses are afflicted. See the articles Cough and Bronchitis.

Inflammation of the eye, in its specific and blinding form, will be noticed in the article Ophthalmia. Common or simple inflammation of the eye is always reducible, but often becomes exasperated by foolish and cruel treatment. It commences suddenly, and arises either from catarrhal affection or from external mechanical injury; and exhibits swelling of the eye-lids, some flow of tears, some red streaks in the white of the eye, and a slight dimness of the cornea; and is commonly unattended with any loss of appetite, or any impairment of the general health. In slight or ordinary cases, it will subside and disappear if simply let alone; and in annoying or very bad cases, it requires only the removal of any minute irritating substance which may happen to have caused it, and the use of a cooling lotion, a gentle purgative, and a mash diet. A temporary opacity or obscuration which often accompanies common inflammation of the eye, is mistaken by many grooms and farriers for the granulations which rise on the surface of the cornea in some rare varieties of eye-disease; and, though a matter of little consequence, and certain to wear off if simply left to itself, is ignorantly and barbarously regarded as a slough which only some powerful caustic can eat out, or as an accretion or eschar which only some such mechanical agent as powdered glass can grind away. "In inflammation of the eye," remarks Professor Dick, "whether arising from external injuries or from other causes, there is an increased action of the arteries of the part; the eyelids appear red and inflamed, and the transparent parts become opaque. This arises from the different caliber of the vessels. Those in the eyelids formerly conveyed red blood, and have now only such an increased quantity injected into them, that they are distended and full, and the whole appears red; while those in the transparent part of the eye, being so minute as only to allow the serous part of the blood to circulate through them, have seldom a red appearance, but rather seem opaque, in consequence of the vessels being now distended and injected with a greater quantity, and perhaps more opaque parts of the blood; and although the red particles be still generally excluded, the opacity, then, is nothing more than inflammation of the transparent part of the eye, which is prevented, in ordinary cases, from becoming red like other inflamed parts, and must be viewed as the process by which the injured part is to be restored; and though commonly called the slough, is not in ordinary cases a substance upon the cornea, but is a change which has been produced in itself."

Inflammation of the lungs will be discussed in the article PNEUMONIA; of the pleura, or enveloping membrane of the contents of the chest, in the article PLEURISY; and of the peritoneum, or enveloping membrane of the viscera, in the article PERITONITIS. Inflammation of the heart is discussed in the article CARDITIS; of the stomach, in the article GASTRITIS; of the abomasum of sheep, in the article BRAXY; of the intestines, in the article ENTERITIS; of the mucous membranes, in the article CATARRH; and of the lower part of the windpipe, in the article BRONCHITIS. Inflammation of the horse's feet is noticed in the article FOUNDER; and other external local inflammations of various kinds, in the articles BROKEN-KNEES, BRUISE, ABSCESS, WOUND, and many others.

INFLAMMATORY FEVER. Diffused inflammation accompanied with high febrile action. It has so intermediate a character between general inflammation and idiopathic fever, always more or less blending the characters of both or vacillating between, as seldom to possess a distinctive character of its own; and, according as it exhibits a preponderance of the one or of the other, it may be treated wholly as inflammation or wholly as fever. See the articles INFLAMMATION and FEVER.

An inflammatory affection, unaccompanied by any local determination to a particular organ or part, often appears in sheep, and is usually known as fever. Its symptoms are general heat, throbbing, and loss of appetite. The proper treatment of it, so long as it continues to be truly diffused, are to bleed copiously from the neck, to give as much aperient medicine as will keep the bowels freely open, to drench with cooling drinks, and to feed with warm mashes or thin gruel. But when much pain is evinced on touching the belly, the flanks, or any other particular part, fomentation ought also to be practised, and must be patiently continued for an hour or more at a time in order to be effective.

A peculiar and intense inflammatory fever, popularly called quarter-ill, quarter-evil, black-quarter, shot-of-blood, joint-murrain, and blood-striking, frequently occurs among the best calves and young cattle of fine feeding districts, and sometimes makes dreadful havoc. It has a considerable variety of character, and would probably be divided by a systematic nosologist into a number of quite distinct diseases; yet in all cases, it has a similar origin, and requires similar treatment, and is in some way or other a real and virulent inflammatory fever. "Its characteristic symptoms," in the form popularly called quarter-ill, and more or less in the forms, which bear the other popular names, "are general disturbance of the circulation, feeble, rapid pulse, weakness, prostration of strength, determination of blood to particular, but in different instances and epidemics, very different parts, producing pain, and manifesting a tendency to inflammation, but of a degenerate kind, so that the very texture of the tissue becomes disorganized. The progress of the disease is often rapid, and the result very fatal. In some cases, the lungs or heart are attacked; in others, the liver, bowels, or even some external part of the body."

This disease arises remotely from excessively nutritious feeding, and proximately from excessive fulness of blood in the system; it occurs principally in spring and autumn, when the food of stock is both most plentiful and most nourishing; it seldom attacks the animals of poor pastures at any season, or of good pastures at the height of summer; and it is most to be apprehended when the herbage is prime in spring, and the stock are quite young and very thriving. It has often been ascribed to the presence or excess of acrid plants, but is really due to the luxuriance and richness of the finest herbage. It sometimes assumes the appearance, or is accompanied with the phenomena, of an epizootic, and is even occasionally called an epizootic or an epidemic by some of the best veterinary writers; but it owes its apparent epizooticism, in no degree to any diffusive or communicable virus, but solely to general predisposition to fever in a flock, from excessively rapid and plethoric feeding. Even when a visitation of it is preceded by sudden and great transition from long-continued cold weather to genial, stimulating, and sustained heat, the meteorological change induces the fever, not by any direct action upon the animal system, but entirely through the medium of the aroused, vigorous, and powerfully enriching herbage. In fact, all farmers who suffer inconvenience or loss from the appearance of this malady among their flocks, have nothing to blame for it but their own ignorance, inattention, or greed. "When cattle are moved from a poor to a more luxuriant pasture," remarks Youatt, "if the grass is sufficiently high, they distend the paunch almost to bursting, and hoove is the result; but if the change is more in the quality than in the quantity of the food, the evil is more slowly produced, and it is more fatal,—a disposition to inflammation is excited, which wants but a slight stimulus to kindle into a flame. It is the penalty which the breeder must pay, or the evil which he must carefully and not always successfully endeavour to avoid, when he is endeavouring to obtain all the advantage he can from the richness of his pasture, and the aptitude to fatten and early maturity of his cattle." "When the supply of food is greater than the exigencies of the system require," says Professor Dick, "an animal usually becomes fat, but still may be tolerably healthy. When, however, a sudden change is made from poor to rich feeding, not fatness but plethora may be the consequence; more blood is formed than the system can easily dispose of, and it becomes oppressed. The effect is often witnessed in cattle and sheep, which, after indulging for a time in luxuriant pasture, take what is called a shot of blood. All at once they become very ill; some part of the body swells, becomes puffy as if containing air, and in two or three hours the animal is dead from the quarter-evil. Upon dissection, a large quantity of black and decomposed blood is found in the cellular membrane, which during life was distended."

Prevention, and not cure, should be studied. Calves in a low condition ought not to be put upon rich herbage; young cattle in even good condition ought not to be suddenly transferred from a bare pasture to a luxuriant one; and fat stall-fed cattle ought neither to be pampered in the house nor driven far or rapidly on the road. A useful preventative, at the time of turning out calves to pasture, is to pass a piece of tape or soft cord under a portion of the skin of the dewlap with a seton needle, to produce counter-irritation; and if it be tied at the ends, and have been doctored with turpentine or cantharides ointment, it may be moved from side to side, three or four times a-week, or oftener or seldomer, so as to maintain the counter-irritation at an uniform pitch and in any degree which may be required. Another preventative, though of slight power, and fitted to act only as a condiment and a corrector of succulence, is a quantity of salted hay, so placed in a moveable crib within the field as to be not only quite accessible to the young cattle, but tempting to their appetite. A third preventative, suited to such individuals as seem already to have become plethoric, is to subject them to as much bleeding and purging as may seem requisite to reduce their plethorism and to subdue their predisposition to fever. But when an attack of the disease has actually been made, a cure is nearly hopeless, and may be attempted only by drawing away almost as much blood as can be got, administering a powerful dose of Epsom salts, and, after the pulse has become quieted and the salts have taken effect, exhibiting sedatives and applying external counter-irritants.—*The Farrier and Naturalist.—Thomson's Lectures on Inflammation.—Percivall's Hippopathology.—Dick's Manual of Veterinary Science.—Philip on the Vital Functions.—Youatt on the Horse.—Blaine's Outlines of the Veterinary Art.—White's Veterinary.—Clater's Works.—Spooner on Sheep.—Youatt on Cattle.—Journal of the Royal Agricultural Society of England.—Quarterly Journal of Agriculture.—Transactions of the Highland Society.*

INFLORESCENCE. The manner in which a phænogamous plant flowers, or the position and arrangement in which its flowers are produced. Solitary flowers are cauline when they grow on the stem, rameal when they grow on the branches, axillary when they grow at the joints or wings of either stem or branches, and terminal when they grow at the top of either stem or branches; but they seldom, by their mere position, afford characters of any great value in systematic botany. Aggregate flowers, or such as grow in groups, constitute about a dozen definite forms, or classes of form, very different from one another in arrangement and appearance, and often of great and striking use in distinguishing species of plants, and sometimes of eminent importance in determining genera, tribes, and even entire orders. When a group of flowers is aggregated into a globular form, at the extremity of either stem, branch, or common peduncle, it is a head; when verticillated or rayed round either stem or branch as a common axil, it is a whorl; when arranged in simple succession upon a vertical or terminal axis, as in wheat or barley, it is a spike; when arranged in regular compound succession upon a vertical or terminal axis, or with secondary or tertiary subdivisions of that axis, it is a panicle; when arranged in such compound succession upon a vertical or terminal axis, that the lower pedicels or subdivisions are comparatively large and horizontal, and the upper ones comparatively small and upright, it is a thyrse; when arranged upon individual pedicels which are attached to a common elongated axis, as in the currant, it is a raceme or cluster; when arranged upon individual pedicels which are attached at different points to a common vertical axis, and have such relative lengths as place all the flowers upon one plane or level, it is a corymb; when arranged in the same general manner as in the corymb, but so crowdedly or condensedly as to have a bundled appearance, it is a fascicle; when arranged upon peduncles which radiate upwards from a common axil like the rays of an umbrella, and place the flowers quite or nearly on one plane, it is an umbel; when arranged in a similar general manner to that of the umbel, but so fastigiately and with such different lengths of pedicel as to have a tuft-like appearance, it is a cyme; when arranged with scaly bracts upon a common and elongated receptacle, and consisting of flowers or florets which want either calyx or corolla or both, as in the poplars and the willows, it is a catkin; and when arranged compactly round a fleshy axis which is enveloped in a spathe or floral leaf, as in the palms and the aroideæ, it is a spadix. When the vertical axis or common and elongated receptacle of aggregate inflorescence terminates in a flower-bud, the inflorescence necessarily ends with that bud, and is said to be definite; and when the axis or receptacle terminates in a leaf-bud, the inflorescence may go on developing member after member or series after series, and is said to be indefinite. When the main axis so produces the aggregate of flowers as to evolve it from the centre outward, the inflorescence is called centrifugal; and when the main axis so produces the aggregate of flowers as to develope it from the circumference inward, the inflorescence is called centripetal. But these two last distinctions are more curious than valuable.

INFLUENZA. Epidemic or epizootic catarrh. It is also called distemper and catarrhal fever; and though commonly described as epidemic or epizootic, it is thought by a few writers not to possess this character decidedly or at all,—and it likewise appears sometimes as an endemic, and sometimes with circumstances which seem to indicate its being contagious.

Influenza in the horse is often a serious disease, and always demands prompt and sedulous attention from the groom or owner. It sometimes begins suddenly; and if the commencing symptoms be violent, it may very speedily proceed to excessive feverishness. The usual commencing symptom is a shivering fit; the symptoms which usually follow and become established within twenty-four hours, are increased heat, accelerated respiration, serous discharge from one or both nostrils, inflammatory reddening of the nostrils, moistness, redness, and dulness of the eyes; frequent symptoms within about a day, are "quidding" of hay, gulping down of water, heaving at the flanks, and a painful but not loud cough,—combinedly indicating soreness of throat and general inflammatoriness of the respiratory organs; and some symptoms in the more advanced stages of bad cases, are either swellings of the head, the belly, and the limbs,—or mild but prostrating forms of bronchitis or pneumonia,—or excitement of the brain, stupefaction, unconsciousness, and delirium,—or lividness of the nostrils, fœtidness of the breath, fœtidness and bloodiness of discharge, and the other indications of some malignant and typhoid form of fever. A symptom which characterises the disease in all its varieties, and from almost the first stage onward, is debility; but the aggregate symptoms are exceedingly various, at once in kind, number, and comparative violence; and not only do they widely differ in different districts, different stables, and different individuals, but those which are prominent in one year may be totally unknown in another.

The great cause of influenza in the horse is generally supposed to be some subtle but unknown principle in the atmosphere, acting on a peculiar aptitude of constitution for the disease; and either this principle engendered or energized, or the aptitude for it in the constitution produced or exasperated by cold, moist, ungenial weather,—particularly such as frequently prevails about the time of the equinoxes, and occasionally in winter. Yet it prevails more in spring than at any other season,—more among the horses of cities, towns, and hot stables, than among those of the open country and well-ventilated stables,—and incomparably more among young horses, and horses in high condition, and horses which have been pampered by indulgence or fed up for sale, than among horses of middle age, in ordinary condition, and either statedly worked, or regularly exercised; it sometimes extends over whole districts or almost every spot throughout town and country, and sometimes confines itself to very limited localities, and appears as strictly an endemic; and it may pass over multitudes of horses stabled one by one or two by two, or at least in no greater number than three in each stable, and may attack every one of ten or a dozen horses housed together in a stable of quite as large area and as abundant ventilation as any five or six stables for horses by two and two. This last fact seems almost to imply that the disease is contagious; and, at all events, suggests an important measure of prevention.

The treatment for the premonitory stages, when these happen to be observed, may be the same as for common febrile symptoms. The treatment for the subsequent stages must entirely depend on the character both of the aggregate symptoms and of the predominating ones; it must have very special reference to the comparative ascendency of febrile symptoms on the one hand, or of inflammatory ones on the other; and, in all bad cases, especially if they vary and fluctuate in their indications, it demands the exercise of at once much skill, sound judgment, and great caution on the part of the practitioner. In every case, no stronger diet must be allowed than mashes and thin gruel. If inflammatory action be considerable, and the horse be strong enough to walk with perfect steadiness, and the disease have not gone beyond the third or fourth day, from three to five quarts of blood may be taken. Yet both the necessity for bleeding, and the patient's decided ability to undergo it without injury, must be quite apparent; and this remedy, except in a very extraordinary case, must not be repeated. The bowels ought to be in a free yet not relaxed state; and if they have been in even a slight degree costive, back-raking, laxative clysters, bran mashes, and, if requisite, some mild aperient must be used; while, if the opposite condition be in existence or set in, a little opium or catechu and starch must be given. If fever be comparatively slight, or not such as to indicate any tendency to a malignant type, the same febrifugal course may be pursued as in catarrh, or a ball containing two drachms of antimonial powder, two drachms of cream of tartar, and three drachms of pulverized saltpetre may be given every twelve hours, or, in the event of great soreness of throat, a medicated drink of a character equivalent to such a ball may be administered. If the throat be very sore, or the submaxillary glands or the parotids be swollen, some mildly blistering matter may be applied; and if the windpipe and the bronchial passages become inflamed, blistering must be promptly practised as far down as the disease goes. If the horse lose appetite, and take little or no food, a due quantity of nourishment, in the form of oatmeal gruel or linseed tea or hay-tea or malt-infusion, must, from the third or the fourth day onward, be administered to him by means of the horn, or he may, if possible, be coaxed to eat a little choice clover hay or good green fodder by hand-feeding. Some of the most distinguished veterinarians recommend the maintaining of surface warmth by means of clothing, and the combining of this with the constant and free admission of pure air.

A really malignant or typhoid termination of equine influenza has been denied or at least doubted by some veterinarians, and certainly is now of comparatively rare occurrence. But when it does appear, it must be promptly and energetically treated, the putrid tendency of the disease must be counteracted, the strength of the patient must be kept from sinking, the atmosphere of the stable must be kept cool, fumigations with hot vinegar must be often made, the washing of the walls and other parts of the stable with a solution of the chloride of lime must be practised, malt mashes and nutritious clysters must be administered, and, in very bad cases, port wine, or good ale, and also some judicious exhibition of laudanum, sweet spirit of nitre, and perhaps some other matters of tendency congenial with these, may be given.

Influenza among cattle is often a more serious affair than influenza among horses, and differs considerably from it in the most common aggregate of symptoms, and passes far oftener into the form of malignant fever, but then takes the name of murrain. See the article MURRAIN. In some seasons, particularly in a variable spring succeeding a mild and open winter, it is very general, and sometimes very severe. Some of its most frequent symptoms are obstinate costiveness, fœtid breath, excessively fœtid discharges, swellings and tumours in the neck, back, loins, and other parts, and violent inflammatory fever. The remedies must be both prompt and vigorous. The cow-house should be both warm and well-ventilated; mashes and green meat must be the diet; aperients, more or less accompanied with aromatics according to the degree of fever or debility, must, in all cases of costiveness, be administered; blood must be drawn to an amount proportionate to the reduction of the inflammatory action, but with cautious reserve against the approach or especially the establishment of debility; and emetic tartar, saltpetre, and digitalis may be variously exhibited during the continuance of fever, and laudanum, sweet spirit of nitre, ginger, and gentian, after the fever subsides. But the medicinal part of the treatment must be greatly modified, and ought always to be controlled, by the peculiar character, aggregation, and succession of the symptoms. See the articles CATARRH and INFLAMMATORY FEVER.

INFUSION. The extraction of the volatile, aromatic, and most readily soluble principles of vegetable substances in water. An infusion may be made either by simply immersing the vegetable substances for some time in cold water, or by putting them into a close vessel, pouring hot water upon them, closing the vessel, and allowing them time to digest. A cold infusion is generally weaker and more grateful than a hot one; and hot infusions vary in strength and gratefulness, according to the temperature of the water, the subdivided or pulverized state of the vegetable substances, the form and character of the vessel, the duration of the digestion, and the comparative rapidity or slowness with which the heat is allowed to escape. The soluble principles commonly extracted along with the volatile and the aromatic principles are sugar, gum, salts, tannin, bitter principles, and all those matters which were classed, in the old chemical nomenclature, under the name of extractive. Much heat and long digestion extract semi-resinous and other coarse refractory principles, and at the same time dissipate the finer aromatic and volatile principles which aggregately constitute the "aroma" or gratefulness of the infusion. The best shape of infusion-vessel has a somewhat spherical body and a cylindrical neck. Infusions for the purposes of beverage and diet are often called teas,—as hyssop-tea, linseed-tea, and hay-tea. Infusions for medicinal purposes are very numerous and exceedingly various.

INGA. A genus of evergreen, ligneous, tropical plants, of the mimosa division of the leguminous order. About 40 species, varying in natural height from 6 to 70 feet, and most carrying either white, pink, or purple flowers, have been introduced to the hothouses of Britain; and nearly 80 more are known to botanists. All the introduced species are beautiful; and one or two of them rank in their native regions as fruit trees. One of the longest and best known is described as follows by Miller: "It grows naturally on the north side of the Island of Jamaica, and on the Spanish Main. It rises with a woody stalk 15 or 16 feet high, covered with a white bark, sending out many crooked irregular branches which hang to the ground; these are garnished with winged leaves, composed of 3 or 4 pair of oblong oval lobes, placed opposite on a midrib, which has a border or wing on each between the lobes; they are covered with a brownish down on their under side. but are of a lucid green on their upper side. The flowers come out in spikes toward the end of the branches, each standing in a distinct empalement, which is tubulous, and divided into five segments at the top, having a great number of very long purple stamina, and are succeeded by long fleshy pods, three quarters of an inch broad, filled with a sweet pulp, in which the seeds are lodged; this pulp is frequently eaten by the negroes."

INHALATION. See Absorption.

INJUNCTION. A prohibitory writ, issued by the order of a court of equity, restraining a person from doing some act which appears to be against equity, and the commission of which is not punishable by the criminal law. An injunction may be obtained to stay waste, as where a tenant for life, or years, is proceeding to cut down timber which he has no right to cut; to prevent vexatious litigation in the courts of common law, as where a man persists in bringing actions to recover an estate, notwithstanding repeated failures; to enable a man to make a just defence, which he could not make at common law, as where the legal defence to a claim rests exclusively, or to a great degree, in the knowledge of the party advancing the claim; to prevent infringement of a copyright, or a patent, &c. See Interdict.

INOCARPUS. A small evergreen Polynesian fruit-tree, of the sapota family. It constitutes a genus of itself, and takes for its specific name *edulis* or the eatable. It was introduced, some years before the close of last century, from Polynesia to the hothouses of Britain. Its stem naturally attains a height of about 25 feet; its flowers are white; and its fruit is oleaginous, and has a fibrous envelope. This plant is closely allied to the butter-trees of the West Indies and other hot countries.

INOCULATING TURF. See Grass Lands.

INOCULATION, in horticulture. See Budding.

INOM. Barley sown the second crop after summer-fallowing.

INSECTIVORA. Animals which live, or are thought to live, on insects. Divisions of this sort cannot be very exact. Some Insectivora drink blood with delight, or eat grass occasionally; and some of the beasts of prey, whose principal food is larger game, are fond of flies. Among birds, the Insectivora form a very numerous class.

INSECTS. The most extensive class of animals. The limits of the class are disputed; but, upon even the narrowest system, they comprise the chief portion of articulated animals, or of those multitudes of species who possess a sort of external skeleton of rings or segments.

The Classification of Insects.—The name insects properly means objects or creatures which are cut into numerous parts or divided into numerous segments; and was applied by Linnæus and the older naturalists to all animals who have the chief divisions of their body connected together by slender points of attachment. But the wingless portion of the group were found by subsequent naturalists to be widely diversified in structure and physiology; and the majority of them are regarded by most naturalists of the present day as quite distinct from the true insects, and as constituting entirely different classes of Articulata. The Linnæan genera *Cancer*, *Monoculus*, and *Oniscus* constitute the modern class *Crustacea;* the Linnæan genera *Scorpio*, *Aranea*, *Acarus*, and *Phalangium* constitute the modern class *Arachnida;* and the Linnæan genera *Scolopendra*, *Julus*, *Lepisma*, *Podura*, and *Pediculus* have been raised by some naturalists into other classes—the first and second under the name of *Myriapoda*, the third and fourth under that of *Thysanoura*, and the fifth under that of *Anaplura*—and are variously and conflictingly treated by other naturalists as orders or genera of insects and arachnida. Yet some of our ablest living entomologists are far from being newfangled enough to lose conceit of the Linnæan classification. Mr. Westwood, for example, says, "I would not willingly be charged with veneration for the works of our predecessors in science, merely because they happen to be old; but I do object to the spirit of innovation which cannot distinguish between what is old and what is good; and if the Linnæan group of insects is to be retained, as I submit that it ought to be, as one of the chief divisions of animals, I would certainly retain for it the name of *Insecta*, which so peculiarly refers to the great character of the group, in preference to that of *Condylopa*, proposed by Latreille. It may, indeed, be said, that it is not proper to apply the name of insect to a crab or a lobster; but they are as strictly insected animals as a bee or a beetle."

In the system of Linnæus, the wingless insects, including crabs, spiders, and millipedes, as well as fleas and lice, constitute only one order, *Aptera;* and the winged insects are distributed into six orders, according to the structure of their wings. Four-winged insects, who have the upper pair of wings crustaceous, with a straight suture, constitute the order *Coleoptera*, and comprise beetles and earwigs; four-winged insects, who have the upper pair of wings semicrustaceous and incumbent, constitute the order *Hemiptera*, and comprise locusts, bugs, aphides, &c.; four-winged insects, who have their wings imbricated with scales, constitute the order *Lepidoptera*, and comprise moths and butterflies; four-winged insects, who have their wings membranaceous and their anus unarmed, constitute the order *Neuroptera*, and comprise dragon-flies, &c.; four-winged insects, who have their wings membranaceous and their anus armed with a sting, constitute the order *Hymenoptera*, and comprise bees, wasps, ants, &c.; and two-winged insects, who have halteres in the place of the posterior wings of the other orders, constitute the order *Diptera*, and comprise flies. In the system of Cuvier, the Crustacea and the Arachnida constitute separate classes; the other Linnæan aptera constitute the four orders, *Myriapoda, Thysanoura, Parasita*, and *Suctoria*, and the winged insects constitute the eight orders *Coleoptera, Orthoptera, Hemiptera, Neuroptera, Hymenoptera, Lepidoptera, Rhipiptera*, and *Diptera*.

The Structure and Physiology of Insects.—The following description of the characteristics of insects applies also to the Crustacea and the Arachnida.

Insects are not furnished with red blood, but their vessels contain a transparent lymph. This may serve to distinguish them from the superior animals, but it is common to them with many of the inferior; though Cuvier has demonstrated the existence of a kind of red blood in some of the Vermes. They are destitute of internal bones, but, in place of them, are furnished with a hard external covering, to which the muscles are attached, which serves them both for skin and bones; they are likewise without a spine formed of vertebræ, which is found in all the superior classes of animals. They are furnished with articulated legs, six or more; this circumstance distinguishes them from all other animals destitute of a spine formed of vertebræ. A very great number of insects undergo a metamorphosis; this takes place in all the winged insects. They frequently change their skin in the progress of their growth. A very great number of insects are furnished with jaws placed transversely. The wings with which a very great number of insects are furnished, distinguish them from all other animals, which are not furnished with a spine composed of vertebræ. Insects are generally oviparous; scorpions and aphides, during the summer months, are viviparous. Insects have no nostrils; are destitute of voice; they are not furnished with a distinct heart, composed of ventricle and auricle. Incubation is not necessary for hatching their eggs. Insects, like all other organized bodies which form the animal and vegetable kingdoms, are composed of fluids and solids. In the four superior classes of animals, viz., mammalia, birds, reptiles and fishes, the bones form the most solid part, and occupy the interior part both of the trunk and limbs; they are surrounded with muscles, ligaments, cellular membrane, and skin. The matter is reversed in the class of insects; the exterior part is most solid, serving at the same time both for skin and bones; it encloses the muscles and internal organs, gives firmness to the whole body, and, by means of its articulations, the limbs and different parts of the body perform their various motions. In many insects, such as the crab, lobster, &c., the external covering is very hard and destitute of organization; it is composed of a calcareous earth, mixed with a small quantity of gelatine, formed by an exudation from the surface of the body. As its great hardness would check the growth of the animal, nature has provided a remedy; all of these crustaceous insects cast their shell annually. The skin of most of the other insects is softer, and organised, being formed of a number of thin membranes, adhering closely to one another, and putting on the appearance of horn. It owes its greater softness to a larger proportion of gelatine. The muscles of insects consist of fibres formed of fasciculi; there are commonly but two muscles to produce motion in any of their limbs, the one an extensor, the other a flexor. These muscles are commonly attached to a tendon, composed of a horny substance, connected to the part which they are destined to put in motion. In most insects, the brain is situated a little above the œsophagus; it divides into two large branches, which surround the œsophagus, and unite again under it, from which junction a whitish nervous cord proceeds, corresponding to the spinal marrow of the superior animals, which extends the whole length of the body, forming in its course twelve or thirteen knots or ganglions, from each of which small nerves proceed to different parts of the body. Whether insects be endowed with any senses different from those of the superior animals, cannot easily be ascertained. It appears pretty evident, that they possess vision, hearing, smell and touch; as to the sense of taste, we are left to conjecture; for we are acquainted with no facts by which we can prove that insects do or do not enjoy the sense of taste. The eyes of insects are of two kinds; the one compound, composed of lenses, large, and only two in number; the other are small, smooth, and vary in number from two to eight. The small lenses, which form the compound eyes, are very numerous; 8,000 have been counted in a common house fly, and 1,700 in a butterfly. The far greater number of insects have only two eyes; but some have three, as the scolopendra; some four, as the gyrinus; some six, as scorpions; some eight, as spiders. The eyes of insects are commonly immoveable; crabs, however, have the power of moving their eyes. That insects are endowed with the sense of hearing, can no longer be disputed, since frog-hoppers, crickets, &c., furnish us with undeniable proofs of the fact. Nature has provided the males of these insects with the means of calling their females, by an instrument fitted to produce a sound which is heard by the latter. The male and female death-watch give notice of each other's presence, by repeatedly striking with their mandibles against old wood, &c., their favourite haunts. Their ears have been discovered to be placed at the root of their antennæ, and can be distinctly seen in some of the larger kinds, as the lobster. The antennæ or feelers seem to be merely instruments of feeling, though some naturalists have thought them to be organs of tasting and smelling; and others, of a sense unknown to us. The amazing variety in the mouths of insects, is evident from the fact, that their whole classification, in the Fabrician system, is founded on it. That insects enjoy the faculty of smelling is very evident; it is the most perfect of all their senses. Beetles of various sorts, the different species of dermestes, flies, &c., perceive at a considerable distance the smell of ordure and dead bodies, and resort in swarms to the situations in which they occur, either for the purpose of procuring food, or laying their eggs.

Insects feed on a great variety of substances; there are few things, either in the vegetable or animal kingdom, which are not consumed by some of them. The leaves, flowers, fruit, and even the ligneous parts of vegetables, afford nourishment to a very numerous class; animal bodies, both dead and alive, even man himself, is preyed on by many of them; several species of the louse, of the acarus, of the gnat, and the common flea, draw their nourishment from the surface of his body; the *Pulex ulcerans* penetrates the cuticle, and even enters his flesh. A species of gadfly (*Œstrus hominis*) deposits its eggs under his skin, where the larvæ feed. Other caterpillars insinuate themselves into different cavities of his body. All the inferior animals have their peculiar parasitical insects, which feed on them during their life. There are some insects which can feed only on one species. Many caterpillars, both of moths and butterflies, feed on the leaves of some particular vegetable, and would die could they not obtain this. There are others which can make use of two or three kinds of vegetables, but which never attain full perfection, except when they are fed on one particular kind; for example, the common silk-worm eats readily all the species of mulberry, and even common lettuce, but attains its greatest size, and produces most silk when fed on the white mulberry. There are a great many which feed indiscriminately on a variety of vegetables. Almost all herbivorous insects eat a great deal, and very frequently; and most of them perish if deprived of food but for a short time. Carnivorous insects can live a long while without food, as the carabus, ditiscus, &c. As many insects cannot transport themselves easily, in quest of food, to places at a distance from one another, nature has furnished the perfect insects of many species with an instinct which leads them to deposit their eggs in situations where the larvæ, as soon as hatched, may find that kind of food which is best adapted to their nature. Most of the butterflies, though they flutter about, and collect the nectareous juice of a variety of flowers, as food for themselves, always deposit their eggs on or near to those vegetables which are destined, by nature, to become the food of their larvæ. The various species of ichneumon deposit their eggs in the bodies of those insects on which their larvæ feed. The sirex and sphex are likewise careful to deposit their eggs in situations where their larvæ, when hatched, may find subsistence. The *Sphex figulus* deposits its eggs on the bodies of spiders which it has killed, and enclosed in a cell composed of clay. Some insects, at different periods of their existence, make use of aliment of very different properties; the larvæ of some are carnivorous, while the perfect insect feeds on the nectareous juice of flowers, e. g. sirex, ichneumon, &c. The larvæ of most of the lepidopterous insects feed on the leaves and young shoots of vegetables, while the perfect insects either take no food at all, or subsist on the sweet juice which they extract from flowers; indeed, the construction of their mouths prevents them from taking any other than fluid food.

We shall now refer to the functions of insects, beginning with respiration, which is the act of inhaling and exhaling the air into and out of the lungs. Mammalia, birds, and most of the amphibia, breathe through the mouth and nostrils. The air, when received into the lungs, is mixed with the blood, and imparts to it something necessary, and carries off something noxious. Some authors have asserted that insects have no lungs; but later experiments and observations show that no species is without them, or, at least, something similar to them; and, in many insects, they are larger in proportion to their bodies than in other animals. In most of them, they lie at or near the surface of the body, and send out lateral pores or tracheæ. The respiration of insects has attracted the attention of many naturalists; and it is found that insects do not breathe through the mouth or nostrils; that there are a number of vessels, for the reception of air, placed along on each side of the body, commonly called *spiracula*, which are subdivided into a number of smaller vessels, or bronchia; that the vessels, or tracheæ, which proceed from the pores on the sides, are not composed of a simple membrane, but are tubes formed of circular rugæ; that the spiracula are distinguishable, and are covered with a small scaly plate, with an opening in the middle like a button-hole, which is furnished with membranes, or threads, to prevent the admission of extraneous bodies. Insects are the only animals without vertebræ, in which the sexes are distinguished. Copulation is performed in them by the introduction of the parts of generation of the male into those of the female. All insects are either male or female, except in a few of the genera of the order hymenoptera, such as the bee, ant, &c., where individuals are to be found, which are neither male nor female, and, on that account, called *neuters*. Among the bees, the neuters form the far greater part of the community, and perform the office of labourers. Among the ants, the neuters are very numerous, and constitute the only active members of the society. It has been alleged, that these neuters are nothing but females, whose parts have not been developed for want of proper nourishment. Oliver, however, after strict examination, is disposed to think them really different, though he does not adduce facts sufficient to establish his opinion. The parts which distinguish the male from the female may be divided into two classes, viz., 1. those which are not directly connected with generation; 2. those which are absolutely necessary for the purposes of generation. The circumstances which have no direct communication with generation, which serve to point out the distinction between the sexes, are the difference of size observable in the male and female; the brightness of the colour in each; the form and number of articulations of the antennæ; the size and form of their wings; the presence or absence of a sting. The male is always smaller than the female; the female ant is nearly six times larger than the male; the female cochineal is from 12 to 15 times the size of the male; the female termes is 200 or 300 times the size of the male; the colours of the male are commonly much more brilliant than those of the female; this is particularly the case in lepidopterous insects; in some insects, the colour of the male is totally different from that of the female; the antennæ of the male are commonly of a different form, and larger than those of the female; frequently the males are furnished with wings, while the females have none; the lampyris, coccus and blatta, and several moths, afford an example of this: the female bee is furnished with a sting, while the male is destitute of one: the males of some insects are furnished with sharp, prominent points, resembling horns, situated either on the head or breast, which are either not perceptible, or very faintly marked, in the female. The parts essential to generation afford the best distinguishing mark; in most insects, they are situated near the extremity of the rectum; by pressing the abdomen near to the anus, they may frequently be made to protrude; but the parts of generation are not always situated near the anus; in the spiders, they are situated in the feelers; in the libellula, the male organ is situated in the breast, while that of the female is placed at the anus. The eggs of insects are of two sorts; the first membranaceous, like the eggs of the tortoise and the other reptiles; the other covered with a shell, like those of the birds. Their figure varies exceedingly; some are round. some elliptical, some lenticular, some cylindrical, some pyramidal, some flat, some square; but the round and oval are the most common. The eggs of insects seldom increase in size, from the time they have been deposited by the parent till they are hatched: those of the tenthredo, however, and of some others, are observed to increase in bulk. At first there is nothing to be perceived in the eggs of insects but a watery fluid; after some little time, an obscure point is observable in the centre, which, according to Swammerdam, is not the insect itself, but only its head, which first acquires consistence and colour; and the same author alleges, that insects do not increase in bulk in the egg, but that their parts only acquire shape and consistence. Under the shell of the egg, there is a thin and very delicate pellicle, in which the insect is enveloped, which which may be compared to the chorion and amnios, which surround the fœtus in quadrupeds. The little insect remains in the egg till the fluids are dissipated, and till its limbs have acquired strength to break the egg and make its escape; the different species of insects remain enclosed in the egg for very different periods; some continue enclosed only a few days, others remain for several months. The eggs of many insects remain without being hatched during the whole winter, and the young insects do not come forth from them till the season at which the leaves of the vegetables, on which they feed, begin to expand. When the insects are ready to break their prison, they commonly attempt to pierce the shell with their teeth, and form a circular hole, through which they put forth first one leg, and then another, till they extricate themselves entirely.

The Destructiveness of Insects.—The injuries which insects inflict upon man are extensive and complicated; and the remedies which we attempt, are often aggravations of the evil, because they are directed by an ignorance of the economy of nature. The little knowledge which we have of the modes by which insects may be impeded in their destruction of much that is valuable to us, has probably proceeded from our contempt of their individual insignificance. The security of property has ceased to be endangered by quadrupeds of prey, and yet our gardens are ravaged by aphides and caterpillars. It is somewhat startling, to affirm that the condition of the human race is seriously injured by these petty annoyances; but it is perfectly true, that the art and industry of man have not yet been able to overcome the collective force, the individual perseverance, and the complicated machinery of destruction which insects employ. A small ant, according to a most careful and philosophical observer (Humboldt), opposes almost invincible obstacles to the progress of civilization in many parts of the equinoctial zone. These animals devour paper and parchment; they destroy every book and manuscript. Many provinces of Spanish America cannot, in consequence, show a written document of a hundred years' existence. "What development," he adds, "can the civilization of a people assume, if there be nothing to connect the present with the past; if the depositories of human knowledge must be constantly renewed; if the monuments of genius and wisdom cannot be transmitted to posterity?" Again, there are beetles which deposit their larvæ in trees, in such formidable numbers, that whole forests perish beyond the power of remedy. The pines of the Hartz have thus been destroyed to an enormous extent; and at one place in South Carolina, at least 90 trees in every 100, upon a tract of 2,000 acres, were swept away by a small, black, winged bug. Wilson, the historian of American birds, speaking of the labours of the ivory-billed wood-pecker, says, "Would it be believed that the larvæ of an insect, or fly, no larger than a grain of rice, should silently, and in one season, destroy some thousand acres of pine trees, many of them from two to three feet in diameter, and 150 feet high? In some places, the whole woods, as far as you can see around you, are dead, stripped of the bark, their wintry-looking arms and bare trunks bleaching in the sun, and tumbling in ruins before every blast." The ravages of the locust are too well known not to be at once recollected as an example of the formidable collective power of the insect race. The white ants of tropical countries sweep away whole villages, with as much certainty as a fire or an inundation; ships even have been destroyed by these indefatigable republics, and the docks and embankments of Europe have been threatened by such minute ravagers.

When we consider that between 10,000 and 11,000 species of insects inhabit Britain, that the individuals constituting these species exceed in most cases all calculation, and that the proportion of about one-half subsists entirely on vegetable substances, we may readily infer that the aggregate amount of damage they occasion to the latter must be very considerable. Many, it is true, derive their sustenance from plants of no direct utility to man, while in other instances, where this is not the case, the injury committed is so slight as scarcely to deserve consideration; and although these deserve to be studied for the purpose of observing their structure, ways, and instincts—always curious and interesting subjects of inquiry—they do not call for attention in any other view. But the case is very different with such as attack the plants to which we are chiefly indebted for our food, or which form the principal support of our domestic animals. The extent to which this takes place is unhappily a matter of daily observation. There is scarcely one of our most useful plants which is not assailed in one way or other; and the forms of insects and their modes of living are so infinitely diversified, as to enable them to continue their depredations in all the different states of these plants. The various kinds of corn, for example, have a host of enemies in the subterraneous larvæ of beetles, which consume the roots; various kinds of caterpillars feed on the blade; some particular species attack the ear; and, even when laid up in apparent security, a small beetle is often found to scoop out the interior of each grain, and convert it into an abode for itself. The turnip, in like manner, is equally exposed to these depredators. If the seed of this useful plant escape the attack of a minute weevil, another enemy awaits the unfolding of the cotyledon leaves, and a third buries itself in the bulb and rootlets, which become diseased and covered with unseemly excrescences; while the mature foliage is often consumed by caterpillars, as was considerably exemplified in the summer of 1836. Many plants have a particular insect appropriated to them; others, as in the examples mentioned, form the food of several different kinds; and when it happens, from some mysterious cause which we are at present unable to penetrate, that these creatures suddenly increase beyond their due proportion, the partial or entire destruction of some of our most valuable crops is occasionally effected by their agency. But even when there is no remarkable augmentation of their numbers, there is reason to believe that the injury occasioned to vegetation by insects is at all times greater than is generally supposed. Their operations are often carried on under cover, either beneath the surface of the soil, within the substance of the plant, or in other situations where they escape observation. Many kinds, again, feed only in the night, and conceal themselves during the day in holes and crevices. In consequence of this latent and insidious mode of attack, there is no doubt that we are often led to ascribe the unhealthiness and decay of plants to badness of soil, unfavourable weather, and other causes, when in reality they are produced entirely by insects. The attention of gardeners and agriculturists, moreover, is seldom directed to their depredations, unless when these become so extensive as to threaten serious injury to their crops; but it is obvious that they must be carried on to a greater or less extent every season, for the existence, at least, of the respective species is always maintained, and this can only take place at the expense of the plants on which they are destined to feed. Whether, therefore, they fall under our observation or not, there is always a host of minute depredators at work, which, in the instinctive prosecution of their own habits and economy, interfere in no inconsiderable degree with the interests of the agriculturist, by preventing the full return which many of his crops would otherwise produce.

In these circumstances it becomes a matter of some importance to inquire into the means which seem best calculated to secure our useful vegetables against the injuries arising from this cause. It may be affirmed that very few efficient remedies have hitherto been discovered; and it generally happens, when noxious insects appear in unusual profusion, that they must either be allowed to ravage our crops unmolested, or if they can be checked at all, it is at a trouble and expense disproportionate to the advantage sought. The only course which is likely to lead to the discovery of proper remedies, is to investigate carefully the habits and natural history of the respective species of insects, in connection with the structure and general physiology of the plants which they attack. In prosecuting this object, the attention should be directed to ascertain the time when, and the manner in which, the eggs are deposited, as well as their composition, and the consistency of the enclosing membrane, with a view to determine in what way the vital principle might be most easily destroyed; for there seems reason to believe that this may occasionally be effected simply by sprinkling them with some kind of medicated liquid, a remedy which would possess the advantage of being easily applied over a great extent of surface. The habits of the larvæ call for particular attention, as it is generally in this state that the mischief is committed. The period of their appearance, their times of feeding, the plants on which they feed, and (if attached to more than one) the kind they seem to prefer, the part of the plant attacked, the duration of the larva state, &c., should be carefully noted. An acquaintance with the places to which the larvæ usually retreat when about to change to pupæ, and with the structure, duration, &c., of the latter, might probably suggest some easy means of destroying many in that dormant state. A knowledge of the economy of the perfect insect is, of course, of the utmost importance. If we could become acquainted with the retreats in which they pass the winter, or find means to destroy the few which generally survive when they first appear in the spring, and before they have deposited their eggs, the injuries which are sustained by their means might be altogether prevented. The progress which the study of entomology has made of late years in this country, enables such investigations to be carried on more easily, and with greater probability of arriving at some successful result, than was the case formerly. The nomenclature and arrangement of this branch of Natural History has been, in a considerable degree, settled, and in general no great difficulty is experienced in assigning its proper place in the system to any given species. By this we have it in our power to determine its name, and to learn all that is previously known of its history; and are thus enabled to give a proper direction to our inquiries, and prosecute them on more scientific principles.

The Serviceableness of Insects.—The benefits conferred by insects, if fully investigated and properly understood, would probably be found vastly more extensive than the injuries which they inflict. "Amongst the *Crustaceous Annulosa*," remarks Mr. Westwood, in his Entomologist's Text-Book, "many species of crabs, lobsters, prawns, and shrimps are employed to a very great extent as articles of food; and even amongst the winged or true insects various species are found similarly serviceable. In the deserts of Africa and Asia, where the locusts acquire a large size, those insects are employed, when dried and preserved, as food. The larvæ or grubs of many large beetles are also devoured by the negroes of India and America; and even the luxurious Romans were exceedingly fond of a large fleshy grub which they called Cossus, and which is supposed to have been either the larva of the goat-moth, *Cossus ligniperda;* or that of the stag-bettle, *Lucanus cervus.* In like manner the white ants, *Termites,* are devoured by the savages of Africa and America; whilst the great quantity of honey annually consumed in every quarter of the world is sufficient to prove, that in this point of view insects are highly beneficial. It has also been recently discovered, that the manna which, it will be remembered, served the Israelites for food during their passage through the wilderness, is but the concreted juice of an Arabian tree, *Tamarix mannifera,* which is caused to flow by the puncture of a small species of *Coccus,* which the celebrated Prussian entomologist, Dr. Klug, has recently described and figured under the name of *Coccus manniparus,* in his splendid work upon the insects of Arabia. In medicine insects are also of great service. Of these the *Cantharis vesicatoria* or blister beetle is the most important. Numerous other species were formerly introduced into the Pharmacopœia, but they have gradually been disused. In a commercial point of view, silk, chermes, and cochineal are some of the most important products. There are many other insects which construct silken cocoons, and emit various coloured dyes, and which it might be very serviceable to endeavour to introduce, as well as the true silkworm and the *Coccus cacti.* Gumlac also, wax and ink-galls are insect productions of too great importance to be passed over without notice. But there are other classes of benefits resulting from the relations of insects with other organized beings. These, although less directly affecting man, ought not to be overlooked in a general survey of the economy of nature. Suppose the race of insects to be entirely annihilated, and then observe the thousands of ills which would inevitably result from the putrefying masses of animal and vegetable productions, and which are now, as it were, reduced to their native elements solely by the interference of the insect tribes. The entire tribes of *Silpha, Necrophagi, Dermestes, Nitidulæ,* immediately fall upon the dead carcasses of animals, devouring the flesh, and accelerating the dissipation of the putrid mass; and these, assisted by myriads of flies, which deposit their eggs in the decomposing body in such immense numbers, succeed, in a very few days, in reducing the carcass to a mere skeleton. In like manner, the *Scarabiadæ* (whose extraordinary habits of rolling their eggs in globules of dung caused them to be regarded as sacred by the Egyptians), the *Geotrupidæ, Histeridæ,* and many other insects, are equally serviceable in burrowing into the earth underneath the fallen excrements of animals, and thus disseminating them, rendering them serviceable to the agriculturist; whilst the tribes of insects which feed upon decaying vegetable matter are even still more numerous. As serving for food to some of the higher animals, as fish, birds, some of the smaller mammalia, &c., insects are eminently serviceable in the scale of the creation. Amongst birds, the shrikes, and the genera *Sylvia*, *Motacilla*, *Anthus*, *Certhia*, *Muscicapa*, and *Hirundo*, as well as the cuckoos and pies; and amongst quadrupeds, the genera *Stenops* and *Otolicnus*, which feed upon grasshoppers, the bats, shrew, hedgehog, mole, and especially the genus *Myrmecophaga*, derive their sole nutriment from insects. Many species of insects are equally serviceable in destroying other noxious insects. Of these the tribes of predaceous beetles, sandwasps, ants, dragon-flies, spiders, &c., are to be noticed, but more especially the larvæ of the lady-birds, *Syrphidæ*, and golden-eyed flies, which destroy myriads of plant lice. All these, however, yield to the *Ichneumonidæ*, which annually destroy more caterpillars than the whole tribes of insectivorous birds, having almost universal dominion over the other insect tribes. In the last place, we have to notice the great services rendered by insects in effecting the impregnation of plants, in many of which the position of the sexual organs is such, that the intervention of insects, especially bees, butterflies, &c., is required, which, whilst seeking food for their own nourishment, unconsciously perform this most important office; whilst some of the *Cynipidæ* effect the more rapid ripening of the fig, by the process termed caprification by the inhabitants of the Levant."

INSECT-ORCHIS. See Ophrys.

INSPISSATION. The thickening of any vegetable sap or other similar juice or liquid into a viscid or semi-solid state by evaporation.

INSTEP. The part of a horse's leg which extends from the hip to the pastern-joint.

INSTINCT. The most perfect animals are infinitely below man, in respect to the degrees of their intellectual faculties; but it is nevertheless certain that their understandings perform operations of the same kind. They move in consequence of sensations received; they are susceptible of lasting affections; and they acquire by experience a certain knowledge of external things, sufficient to regulate their motions, by actually foreseeing their consequences, and independently of immediate pain and pleasure. When domesticated they feel their subordination. They know that the being who punishes them may refrain from doing so if he will, and they assume before him a supplicating air, when conscious of guilt, or fearful of his anger. The society of man either corrupts or improves them. They are susceptible of emulation and of jealousy; and, though possessed among themselves of a natural language, capable of expressing the sensations of the moment, they acquire from man a knowledge of the much more complicated language through which he makes known his pleasure, and urges them to execute it. We perceive, in fact, a certain degree of reason in the higher animals, and consequences resulting from its use and abuse, similar to those observed in man. The degree of their intelligence is not far different from that possessed by the infant mind, before it has learned to speak. But, in proportion as we descend in the scale of creation to animals far below man in organization, these faculties become more languid; and, in the lowest classes, they are reduced to certain motions obscurely indicating some kind of sensation, and the desire of avoiding pain. The degrees of intellect between these extremes are infinite.

There exists, however, in a great number of animals, a faculty different from intelligence, called *instinct*. This power causes them to perform certain actions necessary to the preservation of the species, but often altogether removed from the apparent wants of the individual. These are often so very complicated and refined, that it is impossible to suppose them the result of foresight, without admitting a degree of intelligence in the species performing them, infinitely superior to what they exhibit in other respects. The actions proceeding from instinct are still less the effect of imitation, for the individuals executing them have sometimes never seen them performed by others. The degree of instinct is by no means proportioned to the general intelligence of the species; but it is in those animals which, in their other actions, manifest the utmost stupidity, that instinct appears most singular, most scientific and most disinterested. It is so much the property of each entire species, that all individual exercise it in precisely the same manner, without ever attaining to higher degrees of cultivation.

"Every other animal but man, from the first outset of the species and of the individual, is equal to his task; proceeds in the shortest way to the attainment of his purpose, and neither mistakes the end nor the means by which it is to be obtained. In what he performs we often justly admire the ingenuity of the contrivance and the completeness of the work. But it is the ingenuity of the species, not of the individual; or rather, it is the wisdom of God, not the deliberate effect of invention or choice, which the created being is fitted to employ for himself. His task is prescribed, and his manner of performing it secured. Observe the animals most remarkable for a happy choice of materials, and for the curious execution of their works. The bird, how unvaried in the choice of the matter she employs in the structure, or in the situation she has chosen for her eyrie or nest! Insects, most exquisitely artful in the execution of their little works, for the accommodation of their swarms, and the lodgment of their stores; how accomplished in their first and least-experienced attempts! how uniform and unchanged in the last! Nature appears to have given to the other animals a specific direction to the means they are to employ, without any rational conception of the end for which they are to employ them." Thus, the working bees, from the creation of the world, have always constructed edifices of great ingenuity, upon principles deduced from the highest branches of geometry, for the purpose of lodging and nourishing a posterity which is not even their own. "It is a curious mathematical problem," observes Dr. Reid, "at what precise angle three planes which compose the bottom of a cell in a honey-comb ought to meet in order to make the greatest saving, or the least expense of material and labour; and this is the very angle in which the three planes in the bottom of a cell do actually meet. Shall we ask here, who taught the bee the properties of solids, and to resolve the problems of *maxima* and *minima?* We need not say that bees know none of these things. They work most geometrically, somewhat like a child, who, by turning the handle of an organ, makes good music, without any knowledge of music. The art is not in the child, but in HIM who made the organ. In like manner, when a bee makes its comb so geometrically, the geometry is not in the bee, but in that Great Geometrician who made the bee, and made all things in number, weight, and measure." The solitary bees and wasps construct very complicated nests for the reception of their eggs. From each egg there proceeds a worm which has never seen its mother, which knows not the structure of the prison enclosing it; and yet, after it has undergone its metamorphosis, will construct another nest, precisely similar, to contain its own egg.

No satisfactory explanation can be given of the phenomena of instinct, except we admit that these animals possess some innate and constant internal power, which determines them to act, in the same manner as when they are influenced by ordinary and accidental sensations. Instinct haunts them like a perpetual reverie or vision; and all the actions proceeding therefrom may be compared to those of a man walking in his sleep.

Some of the principles which urge mammalia to act are evidently of the simplest kind. The cries of an infant when in pain or in want of assistance,—the determination of a newly-born animal to the breast and the action of sucking,—the flight of a young animal when influenced by fear, although it has had no experience of danger,—its resistance when we attempt to seize it,—the attention of an animal just born to the cries of its mother, are all actions of this kind. Whether simple or complex, they arise previous to all experience; and have been regarded, by the common consent of all naturalists, as purely instinctive. They proceed from an irresistible and uniform internal power, which leads invariably to the same course of action. But all the actions of animals are not of this uniform description. The dog obeys and does not fly from the whip which his master raises to chastise him. He seeks for the object which has been pointed out, instead of remaining indifferent to the order he has received. If he be confined in a cage with wooden bars, he is agitated with rage and attempts to destroy them; but if they are made of iron, he lies down resigned to his confinement. All these actions are intelligent; and it is the very nature of this intelligence that it is capable of being modified by experience, and of conforming itself to the variable circumstances which incite it to act. Other instances of intelligence may be mentioned. When a horse has to choose between two roads, of which one is known to him, he always takes the latter, however long the period of time since he may have travelled thereon. The dog leaps before his master, and loads him with caresses, when he sees him preparing to go out, and wishes to accompany him. The same animal confines the flock, which has been intrusted to his care, within the precise limits marked out by his master. The wolf attacks his prey openly and by force when in the recesses of the forest; but, if he be in the neighbourhood of a village, he approaches it cautiously and attacks it by surprise. All these actions are evidently intelligent and not instinctive. The slightest circumstance would have induced the horse to take the road which he had not previously travelled. If the dog, by his disobedience, had offended his master, instead of leaping before him with joy, he would crouch and tremble at his feet. We also know that he acquires the remarkable talent of guarding the flock entirely from a previous education, and in being trained expressly for that purpose. On the contrary, it is the common character of instinctive actions to be fixed and invariable; to be constantly produced by the same causes and the same conditions.

We accordingly consider the following actions as instinctive:—the dog, when he hides under ground the remains of his meal; the horse and reindeer, when they remove with their hoofs the snow which covers the earth, to expose the food of which they are in want;—the cows, when they come together in a circle, upon the approach of an enemy, with their heads and horns in the circumference, and their calves in the centre; the beavers, when they build cabins and construct dykes,—when they cut the wood necessary for their edifices, and repair the ravages which time or an enemy has occasioned to their buildings; the rabbit, when it excavates its burrow;—the bird, when it constructs its nest. All these actions, and many others, are presented to us with a certain degree of uniformity, essentially the same in all its more important particulars. The dog hides his food with the same blind instinct, although its superabundant supply renders such a precaution unnecessary. The horse or reindeer that uncovers the grass or moss concealed under the snow, does the same thing when he sees the snow for the first time, and prior to all experience; he acts in the same manner after a meal as when oppressed with hunger. The beaver builds in all situations, under the closest confinement as well as when in the enjoyment of the greatest liberty; when in the possession of the most comfortable abode, as well as when in want of all shelter. The cows, which exhibit so much ingenuity in defending their young when in a herd, do not change their plan of defence though surprised in a small party, and when this method becomes wholly insufficient. The rabbit which takes so much pains to burrow its retreat, knows not how to conceal it, or to adapt its construction to the changes of the seasons, to the circumstances of the place, or to the nature of its enemies. The lower classes of animals present instances still more striking and extraordinary of the blindness of their instincts.

Upon considering all the instinctive actions of animals, we find that these are of a nature very different from their intelligent acts. Instincts are exercised or exhibit themselves only at certain periods; they are always of a limited number in each species, but they go on increasing greatly in number and importance among the lower classes of animals, generally in proportion as their organization differs from that of the human race. Numerous instances might be adduced in support of these views. We at once perceive an immense difference between those intelligent actions which have already been enumerated, alike remarkable for their complexity, and those involuntary instincts, always of great simplicity, which are occasioned by fear, passion, desire, or hunger. The latter seem purely organic,—that is, they result from the direct influence of a superior power,—while, to the former, intelligence appears indispensable. It is also only at certain periods, and for a limited time, that these animals seek their females, prepare their abodes, or construct their nests. The dog, the horse, and the bull, present few actions which can be regarded as instinctive; yet their lives pass on with considerable activity. Their intelligent actions nearly fill up their entire course, and are sufficient for the numerous situations in which they are placed. We can perceive a trace, among the mammalia, of that diminution of intelligence which results from the prevalence of the instinctive acts. The dog presents a great number of intelligent actions, and only a small number of instincts. The bull, on the contrary, leads an active life within very narrow limits; and though his instincts are not positively numerous, they become relatively so, when compared with the very small number of his intelligent actions.

But the marked difference between intelligence and instinct becomes still more striking when we extend our views beyond the limits of the mammalia, and consider the entire animal kingdom. It is then we shall perceive that the quadrumana and carnassiers, which stand at the head of the list, may almost be styled intellectual, if compared to animals of the lower divisions, whose entire existence appears to be swayed by a uniform and constant force. Indeed, were not all analogies between mental and material phenomena altogether inadmissible, we would be disposed to compare the instincts of the inferior animals to those inert powers of Nature which form the prime movers of our own machinery. The most complicated instinct of the dog, requiring for its fulfilment the concurrence of the greatest number of intelligent acts, appears absolutely nothing in comparison to actions of this nature, which may be seen in the invertebrated animals, but chiefly among the insects. In the dog and other mammalia of the higher orders, that instinct which urges them to store up provisions for future want, shows itself only in a few isolated acts. Among the insects, on the contrary, their entire existence, however varied it may appear, seems composed only of one single invariable action, from which nothing external can divert them, and to which they seem invincibly urged by a superior power. None of the mammalia exhibit in any of their actions such a combination of sagacity, foresight, and skill, as might have been inferred from the industry of the bee, did we not see in its actions, proofs of the existence of a mind not its own. Were man incapable of receiving evidence of a Creative Power in his own constitution, he must read it in that principle which urges these lower animals to perform a complicated course of actions, continuing for days and months,—ever directed to one end, and that end invariably the same. He must perceive that wisdom is not the sole property of man, when he finds profound combinations, calculations of the greatest complexity, and the most ingenious views, urging these lower animals to work with a degree of perfection which all his learning and experience, accumulated for a long course of ages, can scarcely equal.

Although we have said that intelligent actions may be varied at the pleasure of the animal, while the instinctive actions are irresistible, these assertions must be understood with some qualification. While performing an instinctive action, the animal always preserves the power of using its senses, and of exercising its intelligence to the degree natural to its species, and employs both in the manner most favourable for the execution of that instinctive action to which it is actuated. An animal is capable of exercising its intelligence in a degree inversely proportional to the force of its instinct. As the instinctive wants become urgent, its intelligence appears more fettered. There is no comparison, for example, in the degree of instinctive force between the hamster (*Cricetus*), which stores up magazines of provisions for the winter, and the dog who hides his superabundant food. Nothing could divert the hamster from its purpose; the slightest circumstance would cause the dog to neglect that precaution.

Having pointed out the difference between intelligent and instinctive actions, we now come to draw the probable line of demarcation between the intellectual powers of man, and the intelligence of the lower animals. We evidently perceive that animals, especially the higher classes, have the power of attention; that their senses require impressions analogous to those we are conscious of experiencing in ourselves; that their ideas follow each other in a certain regular order constituting a train of thought; that a former idea can be recalled; that their ideas are variously associated; and that they can form some conclusions. This seems to be the extent of their powers. We are, of course, reduced merely to conjecture the intensity or qualities of their sensations or perceptions, and are therefore unable to point out those qualities of bodies which can be perceived by man alone. There is, however, one curious circumstance which may be noticed in regard to the sense of hearing. With animals it is a sensation and not a perception; in other words, they are unable to refer sounds to an external cause. If a wild bull or horse feel himself struck violently, he makes no mistake as to the cause. He rushes immediately at the person who has inflicted the blow, even when struck only with a stone or other projectile, just as the wild boar rushes upon the hunter, whose rifle-ball has struck him. But when captive animals, in course of taming, are tormented by a drum or trumpet to prevent them from sleeping, they have no perception either of the instrument from which the sound proceeds, or of the person who plays it. They suffer passively, as if by some internal injury, where the cause of the evil is within themselves. It is curious that their head and ears are notwithstanding directed instantaneously to the precise quarter whence the sound proceeds. It is different with the sensation of colour. The bull rushes at a piece of red cloth, in the same manner as he would have done at an assailant; from which we may infer, that when the horse and bull are unable to refer a sound to its proper cause, it is owing less to the distance which separates them from the instrument, than to the peculiar nature of the sense of hearing. In other respects, they generally seem to have the same senses as ourselves, and to perceive analogous qualities in bodies. Their motions result from the qualities of their sensations; they attempt to fly, to defend themselves, to seize, or to attack, according as they are moved by pleasure or pain. Being capable of forming certain relations to man of a benevolent or malevolent character, they acquire a marked affection for those who treat them well, and a determined hatred to their tormentors. Some species form an attachment for each other solely from the habit of living together for some time, and frequently their mutual hatred arises from mere caprice. These dispositions presuppose memory, and at least some confused knowledge of the relations of those qualities which distinguish one person from another. They exhibit the internal affection of the moment by external signs, which are in general very like those employed by man for the same purpose.

The mammalia acquire from experience a certain knowledge of natural objects,—of those which are safe or dangerous; they avoid the latter in consequence of this experience, and of that memory from which it is derived, without being determined by an instinctive attraction or repulsion. This experience enables them to infer the consequence of their own conduct, when domesticated. They know that a certain action will be punished by their master, and that a contrary one will be rewarded. Their final determination does not proceed from any internal attraction, but often in direct opposition to some very powerful instinct, and from the sole knowledge of the reward or punishment which will follow. This knowledge, besides memory, also presupposes a power of reasoning from analogy, or of inferring that similar causes produce similar effects. Knowing well the power of their master, that he can either punish them or not, they assume before him a supplicating air, on perceiving him to be angry. Their passions and emotions react upon their involuntary functions in precisely the same manner as with man. Surprise stops their respiration; they tremble with fear; terror throws them into a cold perspiration; and love agitates their frames. They may be corrupted or improved by domestication. Habits of ease or luxury create in them artificial wants unknown in the fields or woods. Education may fit them for actions for which they are not adapted by their structure. By proper training they may be rendered docile, mild, and active; or, if improperly managed, they may become more obstinate, passionate, stubborn, or lazy, than Nature had formed them. Race-horses give evident proofs that they are actuated by emulation, and dogs dispute with each other for the caresses of their master. The jealousy of the latter does not merely relate to the possession of their food or other enjoyments wholly physical, but also to the benevolent affections. The natural language of the mammalia enables them to explain to each other the wants or sensations of the moment, and, in their intercourse with man, they understand that more complicated language by which he makes known his commands. Not only do the young know the cry of their mother when she gives notice of approaching danger, but they comprehend a number of artificial words used by man, and act in consequence. We have been acquainted with a gentleman who spoke to his dog only in the French language. The animal would go home, or leave the room at his master's command if announced in the common phrase, but would remain undecided and look into his face with eyes of inquiry when the order was given in an unusual style of language. Some species and genera have very great powers of imitation. There can be no doubt that all the lower animals, without exception, are unconscious of their existence, and incapable of reflecting upon their own condition. They cannot turn their thoughts within themselves, and consider what it is that they see, feel, think, and perform. The acts of their minds, like the movements of their bodies, are the mere result of external causes or of internal instincts. They cannot form the notion of liberty, for this can only be acquired by reflection. For the same reason, they are not moral and accountable creatures. Indeed, it is chiefly to the want of abstraction—of that power by which man forms general ideas, and arrives at general conclusions, that the inferiority of the lower animals may be attributed.

Many philosophers, and especially Condillac, imagined that animals can reflect; and they founded their views upon those invariable actions which we have regarded as instinctive. But there appears to be an evident contradiction, in attributing a constant and seemingly necessary action to a power such as reflection, which presupposes liberty. It is also evident, that if a dog concealed his food from really foreseeing the chance of future want, or, in other words, from reflecting upon his former necessity, and considering the probability of its recurrence, he would not have confined himself merely to set aside a supply of provisions, but would have taken means to provide shelter, a manger—in a word, to procure a supply for satisfying *all* his wants. This method of reasoning is conclusive against our regarding instinctive actions, which are always partial and limited in their application, as the result of reflection. Other philosophers, imagining that the power of reflection was usually proportioned to the force of their original desires, thought that the instincts of animals might still be owing to reflection, as they might depend for their exercise upon the force of the wants or likings of the animal. But if this were the case, the results of reflection would be seen in their most trifling attachments or likings, as well as in their most pressing wants; and this does not agree with observed facts. It is certain, that, for animals generally to satisfy their appetite for food is of the greatest importance, and exercises the most powerful influence over each individual. Also it appears much more indispensable for their existence that it should be satisfied than the want of shelter. Yet we see many animals continuing to dig burrows and retreats, or, according to this theory, appearing to foresee the necessity of providing shelter, and yet the same animals do not foresee that which ought to be most urgent with them, the necessity of laying by a supply of food for future use. All other attempts to explain the actions of animals in a general manner, and without admitting particular faculties, are equally objectionable, and the same thing may be observed in reference to instinctive actions.

To avoid the contradictions which have been here pointed out, some philosophers have thought that the instinctive actions of animals proceeded from some peculiar form of the brain. When stated in the above simple form, this theory presents many difficulties. Its partisans have pointed out what they conceive to be the particular forms which manifest instincts, and have collected many striking coindences in support of their views. We find, it is true, in the structure of their brains certain forms which are in some manner connected with the intelligent functions; but their experiments have not yet demonstrated these functions, and the extreme difficulty of such a task will long render it impossible. In the meantime, it is useless to occupy ourselves with suppositions, which are ever liable to be overturned by future inquiries.

There is a class of phenomena very different from the preceding, which are founded on more certain analogies, and throw some light upon the connexion between intelligence and instinct. We allude to the remarkable effects of habit in transforming an intelligent into an instinctive action. When a man, who has perhaps studied with great care some treatise on the art of horsemanship, attempts for the first time to mount a horse, none of his attitudes or movements, notwithstanding all his science, are what they ought to be. His body falls behind or before when it should be in a vertical position. His limbs are shaken when they ought to remain motionless. In a word, there exists no harmony between his own motions and those of the horse. At first, it is only by a great effort of the mind, that he can perform any one of the requisite movements; afterwards he is able to execute two motions at once, and at length he performs them all simultaneously. But after a little practice, the effort of the mind becomes less necessary, he ceases to pay any attention to the act. In a word, it is no longer an intelligent action, but it becomes instinctive. If the horse make a movement in opposition to the bridle, instantly the motion of the horse communicates to the body of its rider that countermotion proper to restore the equilibrium. This is done also without the slightest reflection, like the winking of the eye, or the turn of the head when a blow is threatened. The power of reflection would arrive too late for the desired purpose, and it is therefore supplied by an action purely instinctive. These differ from the other kind of instinctive actions only in their origin, being acquired by habit, instead of being imparted by nature.

The transformation of intelligence into instinct is capable among many animals of being transmitted to their descendants. We are assured that when rabbits are kept for a long course of years in places where they are unable to burrow, they give birth to races which are not naturally disposed to form these subterranean retreats. Leroy informs us that young foxes, born in countries which are thickly peopled, show, even before quitting their kennel, a much greater degree of cunning and prudence than those living in countries uninhabited by man, and where they have few enemies to fear or to avoid. Certain races of dogs are naturally adapted for hunting, to which they betake themselves instinctively, and without any training, while other kinds of dogs, such as the bull-dog, do not course naturally.

Instinct has been wisely bestowed upon animals by the Creator, to supply the defects of their understandings, the want of bodily force or fecundity; and thus the continuation of each species is secured to the proper extent. There is no visible mark, in the conformation of an animal, by which we can ascertain the degree of instinct which it possesses. But so far as observation has hitherto extended, the degree of intelligence seems proportioned to the relative size of the brain, and especially of its hemispheres. Without venturing to decide upon this point, we must remark that the latter assertion has been controverted by many recent observers, especially by Dr. Herbert Mayo, in his valuable 'Outlines of Human Physiology.' "It does not appear," he remarks, "that an increase in the absolute weight of the brain confers a superiority in mental endowments. Were this the case, the intellects of the whale and of the elephant should excel the rational nature of man. Neither does the relative weight of the brain to the whole body appear the measure of mental superiority. The weight of the human brain is but one thirty-fifth part, while that of a canary bird is one-fourteenth part. Nor in conjunction with parity of form, and structure even, does this relation appear of any value. The eagle is probably as sagacious as the canary bird; but the weight of the brain is but one two-hundred-and-sixtieth part of its entire weight." "We may next inquire," he proceeds, "whether an increasing number and complication in the parts of the brain is essentially connected with improved mental functions. The first instances which occur to the mind are in favour of the affirmative of this supposition. It may be inferred, from their docility and surprising capability of receiving instruction, that birds have higher mental endowments than fish; and, accordingly, in place of the nodules of the fishes' brain, which are scarcely more than tubercles to originate nerves, birds possess an ample cerebrum and cerebellum (or lobes of their brain). But in pursuing this argument, if we compare, on the other hand, the brain of birds with those of alligators and tortoises, we find no striking difference or physical superiority in the former over the latter; yet in mental development, the tortoise and alligator are probably much nearer to fish than to birds. The *instantia crucis* (or decisive experiment), however, upon this question is found in the comparison of the brain of the cetaceous mammalia (such as whales or dolphins), with the human brain on the one hand, and with that of fish on the opposite." "The cetaceous mammalia," he observes, "have brains which, besides being of large size, are nearly as complicated as those of human beings; they might therefore be expected, if the opinion which I am combating were true, to manifest a remarkable and distinguishing degree of sagacity. Endowed with a brain approaching nearly in complexity and relative size to that of man, the dolphin should resemble in his habits one of the transformed personages in eastern fable, who continued to betray, under a brute disguise, his human endowments. Something there should be very marked in his deportment, which should stamp his essential diversity from the fishes in whose general mould he is cast. His habits too, not shunning human society, render him especially open to observation; and the class of men who have the constant opportunity of watching his gambols in the deep, are famed for their credulity, and delight to believe in the mermaid, the sea snake, and the kraken. Yet the mariner sees nothing in the porpoise or the dolphin but a fish, nor distinguishes him except by his unwieldy bulk, from the shoal of herrings he pursues. The dolphin shows, in truth, no sagacity or instinct above the carp, or the trout, or the salmon. It is probable even that the latter, which have but the poorest rudiment of a brain, greatly exceed him in cunning and sagacity. I am afraid that the instance which I have last adduced is sufficient to overthrow most of the received opinions respecting the relation of the size, shape, and organization of the brain to mental development; nor is it easy to find a resting-place for conjecture upon this subject."

INSTINCT (Social). It has long been admitted, that the love of society is an original principle of the human mind, one which precedes all reflection and all knowledge. "Man," says Montesquieu, "is born in society, and there he remains." A kind of instinct overpowers him, and prevails as well in the most savage hordes as among the most cultivated nations. "Send man to the solitude of the desert, he is a plant torn from his roots. The form remains, it is true, but every faculty decays; the human personage and character alike cease to exist." This instinctive feeling is equally prevalent among the lower animals as with man, and it is equally an original principle. It can neither be regarded as an intelligent phenomenon, nor as the result of habit. We find but slight traces of the love of society in many species which possess a very high degree of intelligence, and it would seem that the greatest as well as most remarkable instances of it are found in the lower classes of animals, such as the insects. The proofs that it is not the result of habit are equally convincing. If it proceeded from education, or from the influence of parents over their young, these causes would act with equal force upon all animals which are dependent for the same period of time upon their parents. The bears, which tend and bring up their young equally as long as the dogs, and with the same tenderness and solicitude, ought then to be equally sociable. Yet the bear is essentially a solitary animal. Further, we find with all mammalia that the influence of habit never can prevail over the instinct of nature, that the social instinct lies dormant in some species of animals, although they have never had an opportunity of exercising it; and that it disappears in those species which are not intended for a permanent state of society, although the utmost care be taken to preserve its existence. The uniform experience of the menagerie proves that mammalia, naturally sociable, are always ready to form attachments, although brought up from their earliest moments in solitude. M. F. Cuvier observed this fact on comparing dogs with very ferocious wolves, both kinds being reared in the strictest solitude. The social instinct showed itself in the dogs as soon they had recovered their liberty. On the other hand, young stags, which, in the first years of their lives, formed herds and lived together in society, separated permanently from each other when they had arrived at the age of puberty. The early habits and the social instinct of the last mentioned animals became equally effaced by time.

A great number of mammalia form connexions which are necessarily of a very temporary kind, as they are founded only upon those appetites which disappear when gratified. With these species, the males and females seek each other's society only during the rutting season. The female attends her young with the utmost affection, and defends their lives at the peril of her own, from the moment of their birth; and this affectionate regard continues on her part as long as her breasts are capable of secreting milk. Also the attachment is reciprocal on the part of the offspring, as long as they require her to provide for their wants. But as soon as the rutting season is over, the males absent themselves; as soon as the breasts of the mother cease to secrete milk, and the young can procure their own food, all attachment is at an end; the temporary union is dissolved, and they live apart in the most perfect state of estrangement. Then the slight trace of social habits which they had contracted in their infancy is effaced, each animal becomes a solitary individual, and shifts for itself. The wants of the one animal form the principal obstacle to a neighbour in satisfying its own. This opposition of interest brings on enmity and war, which is the habitual state of all solitary animals in respect to their own species. Among them, force is the only law. The feebler animal avoids the stronger, and dies in its turn if it cannot find a still more feeble animal to destroy, or another solitude to inhabit. This is the order of things which prevails among all the species of the cat tribe, among the martins, the hyænas, and the bears. We find it in all those animals which have no other wants than such as tend either to the preservation of the individual, or to the continuance of the species; and these passions, so far from being the cause of the social instinct, as some philosophers have imagined, are manifestly opposed to all social intercourse. The examples which have just been adduced are afforded by animals presenting habits of the most solitary kind. Nature, however, does not pass at once to the truly social species. Other animals possess the social instinct in different degrees, and modified more or less by other instincts. We find traces of a permanent union in that attachment which exists between the wolf and his female, even beyond the rutting time. The same pair appear to be remotely connected to each other during their entire lifetime, although they only form an intimate union during the rutting season. At other times they go about alone, each seeking its own food, and if they be sometimes seen to hunt in company, it is more from their having the same pursuit than from any social feeling. The influence of these casual meetings in developing the social instinct is but slight, and hence the wolf easily bears a complete separation from his companion. The roe-bucks. *Cervus capreolus*, are an instance of a higher degree of social instinct, but still not in its full extent. Among these animals, the male and female continue always together; they share the same retreat, feed in the same pastures, and run the same chances of fortune. If one of them perish the other does not survive, unless it can find consolation in another individual of a different sex, and in the same solitary condition. But the affection of these animals for each other is exclusive; they do not differ from the solitary animals in respect to their young, and they always separate from the latter as soon as their presence is no longer indispensable for their preservation. In a union such as that last described, the mutual influence of the two individuals is very limited. There is neither rivalry nor subordination, and they acquire habits of the most perfect harmony.

It is different with those numerous animals which are naturally sociable, and live together in bands or troops, although their individual interests are often at variance. We here see the social principle in its full extent, and to a degree which may almost be compared to human societies. It is not merely confined to the union of individuals in a family; but it holds together numerous families, and maintains peace among hundreds of individuals of either sex and of every age. All the individuals of the same herd know each other, and are mutually attached according to the relations which circumstances and their individual qualities have established among them. Harmony reigns until some foreign cause appears. But this mutual feeling exists only for the other individuals of the same herd. A stranger is at first refused admittance, almost always they fall upon him as an enemy, and ill-treatment usually compels him to fly. On the other hand, with every isolated individual the love of society is a want which must be satisfied. At first he follows them at a distance, he gradually approaches, and for the sake of being admitted, gives up his natural will to that point where the instinct of self-preservation urges him either to defend himself or to fly. We may be able to exhibit the state of society which prevails in the troops of wild animals by tracing the life of a young individual from its birth until it becomes the leader of the herd. From the moment that it ceases to be nourished entirely by milk, and to venture out of the ring under the conduct of its mother, it begins to recognise the surrounding localities, its food, and the features of the other members of the herd. The mutual relations of the latter had been previously determined by the incidents of their growth and education, and these same causes exercise a similar influence upon the young animal, whose progress we are now tracing. It can neither fight with the older animals to establish its superiority, nor can it avoid them by deserting the herd; it is not strong enough for the former course, and is prevented from the latter by the social instinct: submission is therefore its only resort. Whenever any circumstance arises which places its interest in opposition to that of the others, the most feeble animal is of course sacrificed. In this case, it must either yield to necessity or escape by stratagem. This is, in fact, the situation of all young mammalia in the middle of the herd. They are very soon taught both the extent of their liberty and of their strength. If they be in a troop of carnivora, such as the wild dogs, when a prey has been hunted down, each individual shares in it, according to the authority which he has been able to exercise over the others. The young animals are left to feed only upon the remains of the feast, or upon such bits as they can carry off by stealth. They attempt to appropriate a few fragments, or to slip in behind the others, happy if they can escape the blows which the older animals deal unsparingly. In this manner, they feed largely if the prey be abundant, but if scarce they die of hunger. By this continual exercise of authority which the older animals sway over the younger, the obedience of the latter is confirmed, and becomes with them a fixed habit. Meantime, the young animals increase in age and strength. Other things being the same, they do not prevail in a battle with those which have preceded them by one or two years, but they are more nimble and vigorous than the younger individuals which have just made their appearance. If force alone prevailed in these societies, the last-mentioned animals would have to yield obedience to the former, but this does not usually happen. The relations which custom has established are preserved, and if the society be conducted by a leader, it is the oldest animal which possesses the greatest power. His authority which originated in force, preserves itself by that habit of obedience which the others have acquired through time. His influence obtains a kind of moral force, founded as much upon confidence as on fear. It ceases to be contested; and it is only those single or combined authorities which are in course of being established that meet with opposition, which they always encounter when the object is one that does not admit of being shared. A joint or combined authority of several animals requires only an equality of strength, aided by a strong social instinct, and the habit of living together in the same course of life. The wild and sociable animals do not fight except when excited by some violent passion, and if we except the cases where they have to defend their lives, the possession of their females, or the latter the safety of her young, they feel no mutual rivalry. The absolute superiority of one animal over another is asserted only when it becomes impossible to share the object: then contests begin, especially during the rutting season. Indeed, it is usually the female, by the marked preference which she bestows upon the younger and more vigorous males, whom she singles out with an extraordinary sagacity, that first induces the latter to assume their proper place, and break through that constraint and obedience which habit had confirmed. There are probably some herds of animals where age alone acquires the force of authority. That such a state of society should exist, it only requires that all their wants should be satisfied, which perhaps takes place among those herds of ruminants, living in the rich prairies of Africa and America, which man has not yet subdued to his use. Their food being always plentiful, could not be with them a matter of rivalry, and but for the females, their lives would pass on in the most profound peace. A contrary effect would be produced where the interests of individuals are at variance; and when food continues long to be scarce, the entire breaking up of the society is the necessary consequence.

Hitherto we have supposed all the individuals composing the herd to be of the same natural disposition. But this is not strictly the case; some are more violent in their passions than others, or their wants are more urgent. One animal is naturally mild and peaceable, another is timid; a third perhaps is brave or passionate, peevish or obstinate; and then the former state of things is disturbed. However, these accidental causes soon produce their effects, each animal obtains its proper influence, and acquires its natural level. New comers gradually become accustomed to yield obedience to those whom they find invested with the command, until their own turn to command arrives, which happens when all the others are newer associates than themselves, or that they are the oldest animals of the society. The social instinct does not only show itself in the mutual affection which the animals of the same herd bear for each other. It is also to be seen in that sentiment of hatred and estrangement which they bear to every unknown individual. Two herds never unite willingly; and if circumstances compel them to do so, violent battles are the result. The males single out the males, the females attack their own sex; but if a single strange individual, especially when of another species, happen to be thrown by chance in the middle of a herd, he can only escape certain death by a timely retreat. From this it follows, that the tract of country occupied by one herd, is in a manner inviolable to all neighbouring herds. It belongs to them by a kind of right. If they be carnivorous, it is there they find their prey, if herbivorous, their pasture. No other tribe in ordinary circumstances ventures to transgress its limits. Any pressing danger, such as a great famine, will, however, serve to break through this natural state of things: and the instinct of self-preservation then bursts through all restraints. But in ordinary cases, the right of property, as well as its effects, may be seen not only in the sociable herds, but even in the solitary species. Every one of the latter considers the place where he has established his residence, the retreat he has prepared, as well as the district upon which he obtains his food, as exclusively his own. The lion permits no other lion to reside in his neighbourhood. Two wolves never inhabit the same district together, except in those countries where they are merely stragglers, and at every moment liable to be hunted to death. The same thing happens with the birds of prey. The eagle from her eyrie extends her dominion over the immense tract of country within the range of her piercing sight.

The state of society above described prevails in every animal association, if we make allowance for their specific characters, such as the peculiar instincts, likings, or faculties which distinguish any one species from the others. But troops or herds of different species present characteristics which are peculiarly their own and which serve to modify the social instinct. In all societies where the natural wants of the individual become very urgent, force prevails in a considerable degree. Among the carnassiers, which are often pinched by the severest famine, the authority of the leader is much more liable to change than among the ruminants. The same thing happens with birds, whose wants and rivalries always proceed to the utmost pitch of fury. On the other hand, particular likings and special instincts may serve to augment and perfect the social sentiment. Many animals unite to the instinct of society that of combining for their mutual defence. Some dig capacious burrows; others erect solid habitations; and it is to the social instinct developed in a high degree that we owe the domestic animals. By separating a sociable animal from the herd to which it naturally belongs, we may acquire some idea of the force of that instinct which urges it to forsake solitude, and live with its own species. Many instances might be adduced illustrative of the powerful affection which results from that sentiment. A cow, a goat, or a sheep, when separate from its flock, feels an uneasiness often fatal to its life. M. F. Cuvier had a Corsican ewe (*Ovis musimon* of *Pallas*) which fell into a declining state, and could only be restored to health by replacing her in the same pen with her companions. Travellers are usually well aware of the danger in meeting a herd of wild horses. Without the greatest precautions, they run the risk of losing all their own horses; for the latter, although domesticated, cannot resist the force of that instinct which urges them to join the wild herd that surrounds and neighs to them. Our domestic animals have always given striking instances of this deep and exclusive affection, which causes them to die of grief when separated from the object of their attachment. This obviously arises from the circumstance explained in a former section, that all the truly domestic animals are sociable in a high degree. Without the social instinct, it is impossible to conceive how these animals could ever have become domesticated, if we consider the very early stage of human civilization when they became so. It is true that by means of kind treatment, continued for a long course of generations, we can succeed in habituating some unsociable animals to live along with us; but this is far from being a real domestication. If man had been originally placed in an unhospitable climate, the necessity of providing for his daily wants would not have allowed him much leisure for experiments on domestication; and had he been placed in one of those fertile countries where every thing is spontaneously bestowed, he would scarcely have subjected himself to a painful and continual industry for so remote an object. Indeed, no savage nation has been found with animals which themselves alone have rendered domestic. On the other hand, we have in the cat an evident proof that unsociable animals do not naturally become domestic. It lives amongst us, accepts our protection, receives our kindness, but does not yield an equal submission or exchange of favours with the really domestic species. If time alone were sufficient to produce domestication, the cat would be as domestic as the dog, the cow, or the horse.

Confidence, among the animals, is always paid to strength. The one succeeds the other; but it is chiefly by the former that authority is maintained. Nature affords numerous proofs of this. We are informed by travellers of undoubted credit, that the wild horses have a chief, the bravest of the herd, who walks always at their head, whom they follow with devotion, and who gives the signal either for flight or for battle, according to the estimate which he forms of the strength of his enemies, or the extent of the danger. But if by accident he falls, the herd, being without a leader, disperses; each individual flies at random; some attempt to join other herds, and many fall victims to their indecision and mistakes. The same thing may be seen among our domestic animals; and the shepherd, in relation to his flock, is nothing else than the strongest individual of the herd, whose strength they have experienced, and in whose skill they repose the greatest confidence. Courage and perseverance are also means of obtaining the command. M F. Cuvier had a Cashmere goat, which was placed in company with three other goats, each of which was at least twice as large and as strong as the former. Yet the little goat managed to get the mastery over the others, although in fighting he lost one of his horns, and thus was deprived of the advantage which the others enjoyed of striking both to the right and left. But his fury and obstinacy were so great, that he ended by obtaining, through dint of perseverance, an authority as complete as if it had proceeded from an undoubted superiority of physical strength. Two of the goats which he had subdued followed their little master everywhere, and when separated from him could not rest until he was restored to them. It cannot be said that this authority on the one hand, and submission on the other, are instinctive. They depend upon accidental and variable causes. They often present opposite features in the same individual; and even the slightest change in the external appearance of the animals is sufficient to dissolve all harmony between them. A trifling circumstance of this kind would cause them not to know each other, and to recommence their battles. If two rams which have long lived together in the most perfect harmony be shorn, they look at each other with fury, and rush together with such violence, that unless separated, they will fight until one of them either flies or remains dead on the spot. Force, however, exercises a very important influence in all animal societies. We even see its influence in places where it might be expected that Nature would oppose some obstacle. In a flock of goats, the she-goat exhibits a remarkable care for her young, and is ready to defend them with her life from the attack of any stranger. But if one of her kids receive blows from any of the other goats of her own flock, she shows no opposition to their violence, and takes no notice of the cries of her young one, provided that they proceed only from the blows of the other members of her society.

It may readily be expected that a herd will separate when famine prevails. Then each animal is attentive only to its own preservation. Some species and individuals even devour each other if driven to extremities. This takes place among the rats (*Mus*), and also, it has been said, among the field-mice (*Arvicola*). A dissolution of the society likewise occurs, when one of the instincts essential to its existence cannot be exercised. In densely-peopled countries, the beavers, instead of constructing habitations, lead a solitary life in the natural excavations of the rocks on the banks of lakes or rivers. These several facts entirely confirm the correctness of those general views which have here been laid down regarding the social instincts of animals; and M. F. Cuvier has contributed more, by his talents and industry, to expose the character and manners of the mammalia, than perhaps any other Naturalist.

The preceding observations serve to shew that there results from the instinctive union of several individuals in herds or troops, a certain mutual dependence, which passes into a habit, and becomes a necessary of life. The authority of one animal over the other originates in force, but when once established, it is maintained by confidence, until passions more powerful than the social instinct arise, and snatch the authority from the chief, to vest it in a stronger and more courageous individual. It is in these mingled states of peace and war that the greater number of animal societies pass their existence, and they are dissolved when the instinct of self-preservation becomes more powerful in each individual than the social instinct. Societies of this description have nothing either intellectual or moral in their constitution. We view, with mingled feelings of astonishment and admiration, a state of things in which authority is maintained without force, where harmony exists without the influence of reason, and a variety of opposite wants and desires, without discord or dissension. We can ascribe this solely to the great First Cause of all things. The animals themselves take no active part in it, and are, under this view of the subject, but the blind and passive instruments in the hand of an invisible and all-powerful Being.

INSURANCE. A contract, whereby, for a stipulated consideration, called a *premium*, one party undertakes to indemnify another against certain risks. The party undertaking to make the indemnity is called the *insurer* or *underwriter;* and the one to be indemnified, the *assured* or *insured.* The instrument, by which the contract is made, is denominated a *policy;* the events or causes of loss insured against, *risks* or *perils;* and the thing insured, the *subject* or *insurable interest.* Marine insurance relates to property and risks at sea; insurance of property on shore against fire, is called fire insurance; and the written contracts, in such cases, are often denominated fire policies. Policies on lives are another description of this contract, whereby a party, for a certain premium, agrees to pay a certain sum, if a person to whose life it relates shall die within a time specified. These policies, however, usually make an exception of death by suicide.

It is not necessary here to dwell on the subject of marine insurance. It may just be remarked that in this species of insurance the risk upon goods usually commences when the goods are actually put on board, and terminates when they are landed or transferred to another ship. —In insurance against fire, risks are commonly divided into common, on which the annual premium is 1s. 6d. per cent; hazardous, 2s. 6d. per cent.; doubly hazardous, 4s. 6d.; and special or extraordinary, on which the risk varies according to the circumstances of the case. But in addition to these premiums, a duty of 3s. per cent. per annum is paid to government, except on farm-stocking, produce, and implements, which are exempted from duty by 3° and 4° Will. IV. c. 23. In 1840, the value of insured property paying duty to Government in Great Britain was £660,524,000; and of farming property insured but exempt from duty £54,715,016. In the year 1844–5 the amount of fire-insurance duty paid in the United Kingdom was as follows:

In England, ...	£935,442
Scotland, ...	68,227
Ireland, ...	49,623
	£1,053,292

Loss by fire occasioned by the acts of a foreign enemy, or civil commotion, is not underaken against; neither is it held to be a loss by fire, if there be no actual ignition. Where loss happens by fire, allowance will be made not only on what has actually been consumed, but also on what has been damaged even by the mere act of removal; but evidence of the amount of actual loss must be exhibited. Of course any misrepresentation as to the nature of the property or the kind of risk to which it is exposed will vitiate the contract. Upon the death of an insured party, the interest is continued in his heir; but when a fire-policy can be assigned to another party only with consent of the insuring office.—Life insurances are absolute or contingent. They are absolute when the sum insured is payable on the death of the party assured; contingent when the payment depends upon some other event, such as the death of another party. They may also be temporary or payable only in the event of the life of the insured expiring within a certain specified time; and deferred where payable in the event of the expiry of the life after a certain time. They may be also effected on joint as well as on single lives. Of course the rates of premium vary with the age of the party on whose life the insurance is effected, and also according as the contract is with a proprietary company dividing the profits entirely among the shareholders; or with a mutual assistance company, having no proprietary, but dividing all the profits among the assured. The selection of an office to insure with is a matter requiring much circumspection. The mode of effecting insurances is explained in the printed prospectuses of the different companies. It is obvious that any concealment of material facts as to the health or habits of the party whose life it is proposed to insure, will be held to vitiate the contract.

INTEGUMENT. The skin and outer membranes of animals, and the husk of seeds or envelope of fruits.

INTERDICT. A form of process in Scottish law for stopping any act or proceedings which may appear illegal or wrongful until the question of right to act on the one side, or to restrain on the other, has been tried before the proper court. The party applying for an interdict must show his title and interest in the matter; and while the propriety of granting an interdict will be discussed, the decision of that point does not rule the ultimate question of right. See INJUNCTION.

INTEREST. A certain allowance paid by the borrower to the lenders of money, for the use of it during some specified time. The sum lent is called the *principal*; the sum paid by the borrower, the *interest;* and both conjoined, the *amount.* If interest, after it becomes due, be incorporated with the principal, and interest be afterwards charged on the successive amounts, it gives rise to what is called ***compound interest***, to distinguish it from simple interest, in which the interest, though foreborn, is charged only on the sum originally lent.

The following are practical rules for computing simple interest.

1. When the rate is 5 per cent. multiply the principal by the number of days, and divide the product by 7,300.

2. When the rate is any other than 5 per cent. multiply the principal by twice the rate and then by the number of days, and divide the product by 73,000.

Ex. 1. What is the interest of £456 for 85 days, at 5 per cent.

$$\text{Interest} = \frac{456 \times 85}{7{,}300} = \text{£}5\ 6\text{s}.\ 2\tfrac{1}{4}\text{d}.$$

Ex. 2. What is the interest of £560 for 240 days, at 4½ per cent.

$$\text{Interest} = \frac{560 \times 2 \times 4\tfrac{1}{2} \times 240}{73{,}000} = \text{£}16\ 11\text{s}.\ 4\tfrac{3}{4}\text{d}.$$

When interest is calculated on a debt, discharged by partial payments, it is reckoned on the several sums due, from the time of the preceding to that of the last payment. This is done most conveniently by multiplying the original sum, and each successive balance, in order, by the number of days intervening between the times of payment, and then dividing the amount of the several products by 7,300. The quotient is the interest at 5 per cent.

Ex.—A bill of £625, due March 2, was paid up in the following manner: April 10, £182; June 8, £250; August 21, £96; and the balance, Dec. 5; what interest was due at 5 per cent.

	£		Days.		Products.
March 2.—Due	625	×	39	=	24,375
April 10.—Paid	182				
Due	443	×	28	=	12,404
June 8.—Paid	250				
Due	193	×	74	=	14,282
Aug. 21.—Paid	96				
Due	97	×	106	=	10,282
Dec. 5.—Paid	97				
					7,300)61,343
					£8 8 0¾

In computing interest on accounts current, or cash accounts, the sums on the debtor and creditor side of the account are added and subtracted, in the order of their dates as they fall due; the several balances are then multiplied by the days as formerly, and if the balance be sometimes due to one party, and sometimes to the other, the products are extended in separate columns.

INULA. A genus of yellow-flowered plants, considerably diversified in species, of the thistle division of the composite order. Three species grow wild in Britain, and are described in the article FLEAWORT; one of two species, now regarded as constituting a separate genus, is described in the article ELECAMPANE; and nearly 40 other species have been introduced to British gardens and British botanical collections from various parts of the world, chiefly Continental Europe and Western Asia.

The savory-like species, *I. saturejoides*, was introduced in the former part of last century from Vera Cruz. It is an ornamental evergreen undershrub. Its stem is branchy, and about 20 inches high; its branches are numerous and hairy; its leaves are opposite, sessile, stiff, and narrow, and send out from their edges pairs of long rigid hairs; its floral footstalks arise at the end of the branches, and are naked and 4 or 5 inches long; and its flowers are solitary, small, radiated, and yellow. This plant is propagated from either seeds or cuttings, and requires stove heat.

Another of the introduced species, *I. crithmoides*, is an ornamental evergreen shrub from Greece; one, *I. tuberosa*, is an ornamental, hardy, tuberous-rooted perennial, from the South of Europe; six or seven are annuals of little interest; and most of the others are coarsely ornamental, hardy, perennial-rooted herbs.

INULINE. A vegetable substance, of closely kindred nature to starch and dextrine. It was discovered by Rose in elecampane, and takes its name from the old botanical designation of that plant, *Inula helenium.* It is spontaneously deposited from a decoction of the roots of elecampane; and it constitutes the greater part of the solid matter of the tubers both of the dahlia and the Jerusalem artichoke. It is a white powder; and consists, according to analysis by Payen, of 46·6 per cent. of carbon, 6·1 of hydrogen, and 49·3 of oxygen. It is insoluble in cold water, and soluble in hot water; and it is deposited from the latter as it cools, and takes the form of globules, which, when seen through the microscope, are diaphanous and adhere to one another like strings of beads. It forms a somewhat mucilaginous solution with boiling water, and a perishable greenish-yellow compound with iodine; and it is readily proved to be distinct from both starch and gum by its insolubility in cold water. But when exposed to a temperature of 367°, it completely melts, acquires new properties, and becomes soluble both in cold water and in alcohol. "Inuline," says Boussingault, "is transformed into dextrine and sugar by the mineral acids; but it possesses certain properties which show it distinct from true starch. In the first place, it is not coloured by iodine; and then acetic acid, which is without action on starch, produces with inuline precisely the same effects as the sulphuric, phosphoric, and hydrochloric acids; finally, diastase, whose reaction upon starch is so peculiar, so prompt, and so powerful, does not cause any change in inuline. It is therefore easy to separate these two substances when they are mingled, by treating the mixture either with acetic acid, which dissolves the inuline, or with diastase, which liquefies the starch."

INUNDATION. See FLOOD.

INVOLUCRUM. The floral leaf, or assemblage of floral leaves in the form of a wrapper, at the base of the umbels or the umbellules of umbelliferous plants. It surrounds the peduncle or the pedicel, either wholly or partially; and in the former case, is said to be complete,—in the latter, dimidiate. Its leaf or leaves are generally strap-shaped; and according as they are one, two, or more in number, it is said to be monophyllous, diphyllous, or polyphyllous. When situated at the base of an umbel, it is properly an involucrum or involucre, and when situated at the base of an umbellule or sub-umbel, it is an involucellum or involucel.

IODINE. An undecompounded principle or element in chemistry. It had escaped the observation of chemists until 1812, when a manufacturer of saltpetre, at Paris, detected it in the ashes of sea-weeds, in the following manner. In evaporating the ley from these ashes, to procure the carbonate of soda which they contained, he noticed that the metallic vessels with which he operated were powerfully corroded, and that the corrosion was increased as the liquor became more concentrated. Having at hand one day a bottle of sulphuric acid, he added some of it to a portion of the mother-water, and was surprised to see a rich violet vapour disengaged; this vapour was the iodine. He communicated the observation to M. Clément Desormes, who set about collecting some of the vapour; and, after examining its leading properties, announced it to the Royal Institute of France as a new body. Its real nature was soon after unfolded through the accurate researches of Gay-Lussac and Sir H. Davy. Its history proved singularly interesting in modifying the then prevailing theory of chemistry. Sir H. Davy had, a few years previously, promulgated the new theory of chlorine, which was still received with suspicion among chemists. The strong analogies, however, between this substance and chlorine, in their relations to combustibles,—both bodies forming compounds by uniting with them, similar to acids containing oxygen, or oxides,—were conceived to give great weight to the views of Sir H. Davy, and operated completely to overthrow the erroneous hypothesis of oxygenation, invented by Lavoisier. Its investigation, therefore, may be said to have formed a new era in chemistry.

The physical properties of iodine are as follow: It is a soft, friable, opaque solid, of a bluish-black colour, with a metallic lustre, usually in scales, but sometimes in distinct crystals of the form of rhomboids or rhomboidal tables, referable to an octahedron, with a rhombic base as their primary form; its specific gravity is 4·946. It possesses an odour somewhat analogous to that of chlorine. It is a non-conductor of electricity, and possesses in an eminent degree the electrical properties of oxygen and chlorine. Iodine enters into fusion at 225° Fahr., and boils at 347°; but when moisture is present, it sublimes rapidly at a temperature considerably below 212°, and gives rise to a dense vapour of the usual violet hue. It is scarcely at all soluble in water, but is readily taken up by alcohol and ether, to which it imparts a reddish-brown colour. It extinguishes vegetable colours, but with less energy than chlorine. It is not inflammable. Its range of affinity for other bodies is very extensive.

It exists most abundantly in the various species of Fucoideæ, which form the greatest part of the sea-weeds of our coast; it also occurs in the sponge, and in the coverings of many molluscous animals, and has been found in a great number of mineral waters, as those of Salz in Piedmont, Saratoga in New York, &c., and more recently has been detected in some silver ores from Mexico, and in an ore of zinc from Upper Silesia. But it is from the incinerated sea-weed or kelp, that the iodine, in large quantities is obtained. As the soap-manufacturers are in the habit of obtaining their soda from kelp, iodine may be procured, very economically, from the residuums of their operation, according to the process invented by Doctor Ure, which is as follows: The brown iodic liquor of the soap-boiler, or the solution of kelp from which all the crystallizable ingredients have been separated by concentration, is heated to about 230° Fahr., poured into a large stone-ware basin, and saturated with diluted sulphuric acid. When cold, the liquor is filtered through woollen cloth; and to every 12 oz. (apothecaries' measure) of it, is added 1,000 grains of black oxide of manganese in powder. The mixture is put into a glass globe, or large matrass with a wide neck, over which a glass globe is inverted, and heat is applied, which causes the iodine to sublime copiously, and to condense in the upper vessel. As soon as the balloon becomes warm, another is substituted for it; and when the second becomes heated, the first is again applied. The iodine is withdrawn from the globes by a little warm water which dissolves it very sparingly; and it is purified by undergoing a second sublimation. The test made use of for the detection of iodine in any solution, when it is suspected to be present, is starch, with which iodine has the property of uniting, and of forming with it a compound insoluble in cold water, which is recognised with certainty by its deep blue colour. The solution should be cold at the time of adding the starch; and, if the colour does not become apparent simply on the addition of the starch, a few drops of sulphuric acid should be cautiously added, when, if any iodine is present, the blue colour will make its appearance. This test is so exceedingly delicate, that a liquid, containing $\frac{1}{450000}$ of its weight of iodine, receives a blue tinge from a solution of starch.

IONIDIUM. A genus of small, ornamental, exotic plants, of the violet family. The name signifies "violet-like," and alludes to the similarity of the plants to the true violets. At least five or six species have been introduced to Britain from the West Indies, Continental America, and the Cape of Good Hope; and a great many more are known. One of the introduced species is a white-flowered, evergreen, summer-blooming undershrub; and is regarded by some botanists as a true violet, under the name of *Viola capensis*. Another of the introduced species is a greenhouse evergreen undershrub; and some others are more or less tender evergreen herbaceous plants.

IONOPSIS. A small genus of very beautiful tropical epiphytous plants, of the orchis family. The earliest species known in Britain, *I. utricularioides*, was brought hither about 25 years ago, from the West Indies; and is a very handsome epiphyte, of 6 or 8 inches in length, with flowers of white and purple predominant-colour, blooming in the latter part of autumn and the early part of winter. Several other species have been introduced. The name is formed from two words which signify "the appearance of a violet."

IPECACUAN, or IPECACUANHA. A powerfully emetic vegetable substance, everywhere known in our drug-shops. The name is South American, and signifies "vomiting root," and is applied by the native population of South America to all roots which possess the property of emetics, and therefore to roots of very different species of plants. The present systematic botany and materia medica of Europe apply the name to six plants of entirely different orders,—the *Euphorbia Ipecacuanha*, a hardy, evergreen, herbaceous, North American perennial, of the spurge order, —the *Ionidium Ipecacuanha* or *Pombalia Ituba*, a stove, evergreen, herbaceous, Brazilian perennial, of the violet order,—the *Cynanchum Ipecacuanha* or *Asclepias asthmatica*, a stove, evergreen, Cingalese twiner, of the swallow-wort order,—the *Richardia emetica*, a tender South American plant, of the order Aroideæ,—the *Psycotria emetica*, a tender South American plant, of the madder family,—and the *Cephaelis Ipecacuanha* or *Callicocca Ipecacuanha*, a tender South American perennial, also of the madder order, and nearly allied to the cinchona genus. Some writers on medical botany also give the name themselves, or assert it to be given by natives, to a number of other plants, particularly *Dorstenia Brasiliensis*, *Polygala poaya*, *Manettia cordifolia*, *Chiococca anguifuga*, *Chiococca densifolia*, *Dorstenia arifolia*, *Cynanchum tomentosum*, *Richardsonia emetica*, and four or five species of the *Violariæ*. But the only ones of all these from which the ipecacuan of our drug-shops is obtained, are, very rarely, *Richardia emetica*, commonly called white epicacuan,—more frequently *Psycotria emetica*, sometimes called grey epicacuan,—and by far the most frequently *Cephaelis ipecacuanha*, sometimes called brown ipecacuan, but largely yielding the grey roots as well as the brown ones of the shops.

The *Cephaelis Ipecacuanha* grows wild, in moist shady places, in the forests of many parts of Brazil. Its root is roundish, two or three lines thick, three or four inches long, and either simple or a little branched; its stem is smooth, brown, knotted and procumbent in the lower part, leafy above, and from 5 to 9 or 10 inches high; its leaves are opposite, almost sessile, ovate, three or four inches long, less than two inches broad, deep green above, and whitish-green and downy below, and fall in such a manner that never more than eight remain, and all these toward the top, at the time of bloom; its flowers are monopetalous, and grow in a head of from 15 to 24 upon a downy cylindrical footstalk; and its fruit is a soft, blackish, one-celled berry, containing two oval seeds. The roots of commerce are imported from Rio Janeiro; and, whether grey or brown, are wrinkled and twisted, and have a resinous fracture. The roots themselves are inodorous; but the fine powder of them has a sickening odour, and a subacrid and very nauseous taste. The powder is liable to become effete; and ought to be kept in small, air-tight phials, completely shaded from the light. This powder is the ordinary ipecacuan of the shops; and consists of gum, starch, lignin, or oily matter, and a peculiar principle which seems to contain all its medicinal properties, and bears the name of emetia or emetine.

Ipecacuan is exhibited to the human subject either in substance or in aqueous infusion, vinous infusion, or syrup; and when given in very minute doses, it acts as a tonic,—in larger doses, as a diaphoretic and expectorant,—and in still larger ones as an emetic. It is of great value to man in the last of these capacities; and, in general, is preferable to every other known substance, in every case in which a thoroughly cleaning though somewhat slowly operating emetic is required. It is valuable also as a sudorific in dropsy, arthritic affections, acute rheumatism, and some other diseases. It likewise possesses the important adaptation of having its action energized by combination with tartar emetic, moderated by combination with opium and gentian, and stopped or neutralized by vegetable acids, by infusions of tanniniferous plants, and especially by infusion of nut-gall. But ipecacuan is by no means so serviceable in veterinary pharmacy; and can be advantageously used for either horses or cattle only as a constituent of Dover's powder,—a mixture consisting of one drachm of ipecacuan, one drachm of opium, and one ounce of vitriolated tartar, and sometimes called Compound Powder of Ipecacuan. The dose of Dover's powder to an ox or a cow in rheumatism is half a drachm.

The peculiar principle emetia, contained in ipecacuan, is one of the alkaloids. It constitutes about 5 per cent. of white epicacuan, about

14 per cent. of psycotria ipecacuan, and about 16 per cent. of prime cephaelis ipecacuan; and is obtained in a separate form by a process of digestion, decoction, distillation, precipitation, and decolorization, for throwing off the other constituents, and rendering the emetia pure. It is a white pulverulent substance; and consists, according to Pelletier and Dumas, of 64·57 per cent. of carbon, 22·95 of oxygen, 7·77 of hydrogen, and 4 of nitrogen. It is insoluble in ether, sparingly soluble in cold water, more freely soluble in hot water, and very soluble in alcohol. It forms neutral salts with acids,—but its salts are scarcely crystallizable; and it is decomposed by any temperature higher than that of boiling water. It has closely similar medicinal properties to ipecacuan; and produces its characteristic emetic purgative, and somewhat narcotic effects upon the adult human body, in the small dose of half a grain.

IPOMŒA. A large and interesting genus of herbaceous plants, of the convolvulus order. It is very nearly akin to the true bindweeds; and produces many a flower which a close unscientific observer would pronounce to be a true convolvulus; and now comprises not a few species which were formerly classed by botanists themselves as true convolvuli. It has a five-parted naked calyx, a five-plaited campanulate or funnel-shaped corolla, an entire style, a capitate two-lobed or three-lobed stigma, a two-celled or three-celled ovary, and a two-celled or three-celled capsule. It equals the bindweed genus in number of known species, very nearly or quite doubles it in number of species in British gardens, considerably excels it in utility, and very far excels it in aggregate beauty and splendour. So far back as ten years ago, about 120 species of it, all exotics, had a place in British collections; and about 80 additional species were known.

The quamoclit ipomœa, *I. quamoclit*, is a twining stove annual; it grows wild in both the East and the West Indies; and it was introduced to Britain in the early part of the 17th century. It is sometimes called by the West Indians sweet-william; and was formerly called by some British gardeners scarlet convolvulus and Indian pink. Its stem is twining, and 7 or 8 feet high; its branches are numerous, slender, and twining, and twist themselves round any neighbouring plant which can support them; its leaves are pinnate, and comprise each several pairs of very fine narrow leaflets, not thicker than ordinary sewing-thread, about an inch in length, of a deep green colour, sometimes opposite, and sometimes alternate; and its flowers come out singly from the side of the stems, and stand on slender footstalks of about an inch in length, and are funnel-shaped, and of a most brilliant scarlet colour, and have a tube about an inch in length, narrow at bottom, and gradually widening toward the outspread, flattened, and five-plaited tops, and usually bloom from July till September. This plant has a superb appearance, and requires to be treated as a tender annual, with all the additional care and appliances suited to its peculiarly twining habits. Its root seems to have at one time possessed some celebrity in veterinary medicine. A variety of this species, *I. q. flore-albo*, has white-coloured flowers.

The reddish-blue ipomœa, *I. rubro-cærulea*, was introduced about 14 years ago from Mexico; and is one of the most splendid plants of the genus. It climbs and twines and weaves itself into festoons to an extraordinary height in its native regions; but it usually attains a height of only about 8 or 9 feet, and requires to be treated as an annual, or similarly to the quamoclit, in the hothouses of Britain. Its stem is twining, smooth, and tinged with purple; its branches are rounded and herbaceous; its leaves stand on footstalks of about the same length as themselves, and are alternate, membranous, entire, wavy, and markedly cordate, with a deep sinus at the base and a sharp point at the top; and its flowers grow in axillary, two-flowered or three-flowered racemes, on footstalks thicker than those of the leaves,—and, while expanding, they are white at the base and become red toward the upper part,—but when fully expanded, they attain a fine purplish or blue colour, and are five-plaited, and have mucronate angles.

Mrs. Horsfall's ipomœa, *I. Horsfalliæ*, was introduced from India, about 14 years ago, by Charles Horsfall, Esq., of Everton; and is probably the most splendid stove climber at present in Britain. Its roots are tuberous; its stem is twining, smooth, woody, and of a dark brown colour, and attains a height or length of 20 feet or upwards; its leaves are pinnate and alternately stalked; its leaflets are five or six in each leaf, ovate, lanceolate, waved, glossy green or dark brown above, and somewhat glaucous below; and its flowers rise from the axils of the leaves on solitary footstalks or in cymes of three, five, or more, and have a bell-shaped corolla, with five heart-shaped lobes, and bloom throughout the autumn and the winter,—and their calyx is dark brown, the tube of their corolla light pink, and the limb rich, shining, dark rose colour; so that, in themselves, and especially in contrast to the peculiar verdure of the full-grown foliage, they make a most magnificent appearance.

The long-leaved ipomœa, *I. longifolia*, was introduced from Mexico in 1838; and ranks as a very splendid half-hardy perennial. Its root is fusiform and long; its stem is branchless, and from 4 to 5 feet high, and, if not tied up to a stick or otherwise supported, becomes nearly prostrate; and its flowers are large and semi-transparent, and bloom in daily succession from July till September, and diffuse a delicious fragrance similar to that of noyeau. This plant loves a strong, rich, moderately dry soil, and prospers best in the shade, and may be readily multiplied from young shoots rising freely out of the root-crowns, and is peculiarly adapted, during the season of bloom, to occupy a place in the sitting-room.

A considerable number of species have a comparatively high character as half-hardy annuals, — particularly, *I. carolina*, a purple-flowered twiner, 10 or 12 feet high, blooming in July and August, and introduced about 115 years ago from North America; *I. purpurea*, a twiner 10 or 12 feet high, blooming from June till September, comprising four permanent varieties with respectively dark-purple, striped, white, and flesh-coloured flowers, and introduced from America in the former half of the 17th century; *I. hederacea*, a blue-flowered North American twiner, 10 or 12 feet high, blooming in July and September; *I. barbigera*, a purple-flowered North American climber, 3 or 4 feet high, blooming from June till September; *I. cærulea*, an azure-flowered East Indian twiner, 9 or 10 feet high, blooming from June till September; *I. lacunosa*, a white-flowered North American twiner, 10 or 12 feet high, blooming in late summer and early autumn; *I. hepaticifolia*, a purple-flowered, East Indian, autumn-blooming twiner, 10 or 12 feet high; *I. lutea*, yellow-flowered, and 8 feet high; *I. Michauxi*, striped-flowered, and 10 feet high; *I. nil*, blue-flowered, and 8 feet high; and *I. triloba*, violet-flowered, and 10 feet high.

The jalap ipomœa, *I. jalapa*, a tuberous-rooted native of tropical America, yields, in its roots, the well-known purging jalap of the drug-shops. See the article Jalap.—The long-rooted ipomœa, *I. macrorhiza*, called by some botanists *I. Michauxi*, and confounded by others with *I. jalapa*, is also a tuberous-rooted and medicinal plant, a native of Georgia, but has white flowers while the preceding species has red.—The panicled ipomœa, *I. paniculata*, is a medicinal, tuberous-rooted native of India, and was introduced about 48 years ago to the hothouse collections of Britain. Its stem attains a height of 20 or 25 feet; and its flowers are pink-coloured, and bloom from June till September. Its roots, dried in the sunshine, reduced to powder, and boiled with sugar and butter, are used on the Malabar coast for promoting obesity and moderating the menstrual discharge.—The roots of *I. quamoclit*, *scoparia*, and *florida*, possess stimulating properties.—The roots of *I. Battatas* are the well-known esculent sweet potatoes of America and Southern Europe. See the article Battatas.—The roots of *I. edulis* are also a wholesome article of diet.

Five tuberous-rooted introduced species, additional to those already mentioned, are *I. eriosperma*, *splendens*, *senegalensis*, *tyrianthina*, and *bonariensis*. Four introduced species, of determinedly creeping habit, and all purple-flowered, tropical, and ornamental, are *I. reptans*, *brasiliensis*, *stipulacea*, and *maritima*. Some of the chief of the many ornamental, introduced species, additional to those already mentioned, are *I. bona-nox*, a white-flowered annual from the West Indies, remarkable for the variation of its leaves, some being entire, and others deeply lobed; *I. Schiediana*, a magnificent perennial-rooted twiner, carrying blue flowers toward the end of autumn; *I. repanda*, an annual, scarlet-flowered, West-Indian climber, blooming in the early part of autumn; *I. grandiflora*, an evergreen, white-flowered, East-Indian twiner, 8 or 9 feet high, and blooming in September; and *I. tyrianthina*, formerly mentioned as tuberous-rooted, a gorgeous plant, carrying rich dark purple flowers in October.

IPOMOPSIS. See Gilia.

IRESINE. A genus of beautiful, white-flowered, frame and greenhouse herbaceous plants, of the amaranth order. Five or six species, one of them an annual, and the rest evergreen herbs, have been introduced to Britain, principally from South America; and all bloom in the latter part of summer and early part of autumn. A woolliness appears in the branches, and is alluded to in the name iresine.

IRIS. A large genus of ornamental herbaceous plants, constituting the type of the natural order Irideæ. This order was formerly called Ensatæ; and has a near relationship to the hæmodorum, amaryllis, and hypoxis orders; but is distinguished, among other characters, by its superior six-cleft perianth, and by such a position of the anthers as disposes them to burst toward the exterior of the flower. The species are naturally distributed through a large portion of both the northern and the southern hemispheres; and about 500, belonging to nearly 40 genera, occur in the gardens and botanical collections of Britain. The great majority are eminently beautiful; many render the native Flora of some parts of the world absolutely gorgeous; and a considerable number make a conspicuous and most ornamental figure in all kinds of British flower-gardens. Some of the most magnificent or best known genera are *tigridia*, *gladiolus*, *ixia*, *ferraria*, *iris*, *sisyrinchium*, and *crocus*. A few, such as the saffron crocus and the florentine iris, are medicinal.

Two species of the genus iris grow wild in Britain; about 100 species, or upwards, have been introduced from other countries, chiefly the temperate parts of the old world; and a considerable number of other species are known. Several of those in Britain are tuberous-rooted; about a dozen are bulbous-rooted; 3 or 4 are herbaceous evergreens; and the rest are herbaceous perennials with annual stems. Five or six require a little protection; and all the others are quite hardy. "The sword-leaved sorts," says Sweet, "do best in a light loamy soil, and increase freely by suckers from the roots or by seeds. The tuberous-rooted ones are more difficult to cultivate, and thrive best in a mixture of loam, peat, and sand; as does also the tribe to which *I. persica* belongs, as *I. alata*, *I. caucasica*, *I. reticulata*, &c. The common bulbous species do well in any garden soil, the more sandy the better." All deserve a place in the flower-border; and the majority are brilliantly and magnificently ornamental. We can afford to notice only the two indigenous species, and three or four of the most common and popular exotic species.

The yellow water-iris, or bastard acorus, or common flower-de-luce, *I. pseudacorus*, grows wild in the ditches, pools, stagnant streams, and moist grounds of many parts of Britain, and forms a handsome natural ornament of multitudes of the close scenes of small moist valleys. Its root is horizontal, depressed, fleshy, brown, and pretty thick, and spreads in every direction near the surface of the ground; its stem has a height of 3 or 4 feet; its leaves are erect, sword-shaped, ribbed, very long, and of a deep green colour; and its flowers are from 3 to 6 in number, and come out in succession one above another toward the top of the stem, and want the three upright petals called standards, and have the three inner petals smaller than the stigmas, and exhibit a yellow ground colour with a pencilling of dark purple on the disks of the larger segments, and bloom in June. The root of this plant is very astringent, and had formerly a place in the materia medica of the colleges. A variety with pale yellow flowers, *I. p. pallida flava*, was introduced about 35 years ago from North America, and is more ornamental than the normal plant. Another variety has variegated leaves.

The stinking iris, or stinking gladwyn, or roast-beef plant, *I. fœtidissima*, grows wild in thickets, in woods, under hedges, and in other shaded situations, on moist soil, in some parts of Britain; but is rather rare. Its root is thick, tufted, and fibrous; its stem has a height of from 15 to 24 inches; its leaves are sword-shaped, and of a grassy green colour, and stand about as high as the stem; and its flowers have a livid purple colour pencilled with dark veins, and bloom in June. When the leaves of this plant are rubbed or broken, an odour is emitted by them which at first resembles that of hot roast-beef, but afterwards, or when closely smelled, becomes disagreeably fetid.

The Florentine iris, *I. florentina*, is a native of Carniola, Rhodes, and various parts of the South of Europe, and was introduced to Britain toward the close of the 16th century. Its root is tuberous, horizontal, and somewhat jointed, and sends off many fibres from below; its stem is erect, simple, naked, cylindrical, and from 15 to 24 inches high; its leaves are sheathing, erect, sword-shaped, and of a sea-green colour, but yellowish at the base; and its flowers commonly amount only to two, and are erect, terminal, and inodorous, and have a pale bluish-white colour, and bloom in May and June. The roots of this plant are imported in a dried state from Leghorn, and have a place in the Edinburgh pharmacopœia, and furnish the orris powder of perfumers. In a somewhat fresh state, they are very acrid, and have a nauseously bitter taste; but in an older and quite dry state, they lose their acrimony, and have a sweetish bitter taste, and are brittle and very pulverizable, and emit an agreeable odour similar to that of the violet. They appear to consist principally of starch, partly of gum and sugar, and in some degree of a fixed oil, a volatile oil, and malic acid. The dried roots are highly prized for their delightful fragrance, but possess little or no medicinal virtue; and even the recent roots, though somewhat cathartic, and occasionally recommended for dropsies, do not deserve to be regarded as officinal. A variety of smaller size than the normal plant, and with light grey coloured flowers, *I. f. minor*, occurs in some gardens.

The German iris or German flower-de-luce, *I. germanica*, was introduced to Britain from Germany in the latter part of the 16th century. Its root is very thick, fleshy, and jointed, brownish without and white within, and spreads immediately under the surface of the ground; its stem is jointed, and has at each joint a small sessile leaf, and divides into three branches, and has a height of from 2 to 3½ feet; its radical leaves arise in clusters from the crown of the root, embracing one another at the base, but spreading asunder in a winged manner as they ascend,—and they are 2 inches broad and from 18 to 30 inches long, and have sharp edges and sword-like points; and its flowers grow in series of two or three, above one another, in sheaths, toward the top of each branch, and have 3 large, bending, blue or violet coloured, bearded petals, besides the arched petals and the standards, and bloom in May and June. A variety with white flowers, *I. g. flore-albo*, occurs in some gardens.

The Susian or Chalcedonian iris, *I. susiana*, grows wild in the vicinity of Constantinople and generally throughout the Levant, and was introduced to Britain toward the close of the 16th century. Its stems rise 24 or 30 inches high, and support each one very large flower; its leaves have a greyish colour, and are not so broad as those of the German iris; its three upright petals or standards are almost as broad as a hand, but very thin, and have a striped colouring of black and white; its three bending petals have a still darker colour, and occasion the plant to be sometimes called the mourning iris; and the flowers bloom from March till May. Some varieties have pale-blue, deep-blue, and bluish-white striped flowers. The name Susian arose from a mistaken supposition that the plant came from Susa, the capital of Susiana.

The xiphium or Spanish iris, *I. xiphium*, was introduced to Britain from Spain toward the close of the 16th century. Its root is bulbous; its stem is about 20 inches high; and its flowers have a mixture or variegation of blue, violet, white, and yellow colours, and bloom in June. A species very similar to it, *I. xiphioides*, is also a native of Spain, and was introduced at an earlier date.

The Siberian iris, *I. sibirica*, was introduced from Siberia about the same time as the Spanish iris. Its root is non-bulbous; its stem is 3 or 3½ feet high; its leaves are comparatively narrow; its bending or falling petals have a light blue colour; its upright or standard petals have a dark purple colour; and its flowers bloom in May and June. One variety, *I. s. flore-albo*, has white flowers, and is not so tall as the normal plant; and another variety, *I. s. flore-pleno*, has purple-coloured double flowers.

The Persian iris, *I. persica*, was introduced from Persia in the former part of the 17th century. Its root is bulbous; its stem is only 2 or 3 inches high; and its flowers display a brilliant variegation of blue and yellow colours, and diffuse a grateful fragrance, and bloom in March. This plant is somewhat tender, and may be grown in a pot filled with equal parts of sand and fine mould, and housed during frost. The fragrance of its flowers renders it a great favourite; yet this fragrance has the curious property of being strongly perceived by some persons, and perceived very faintly or not at all by others.

IRISH HEATH. See MENZIESIA.

IRON. The most valuable of all the metals. Though mentioned in the Pentateuch, we have reason to believe, from the facts that the fabrication of steel was unknown to the ancients, and that they were wholly destitute of metallurgical skill, that its uses were little known in the earlier periods of society. The Romans employed, as a substitute for it in their armour, an alloy of copper and tin. Its use has followed the progress of civilization in the world; and the amount of it consumed by any nation, at the present day, indicates very truly the degree of its advancement in the arts and sciences. In treating of this metal, we shall adopt the following order: 1st, its ores; 2d, their reduction to the metallic state; 3d, the statistics of the iron manufacture in Great Britain.

Ores of Iron.—Iron exists in nature under four different states—the native state; that of an oxide; in combination with combustible bodies, particularly sulphur; and, finally, in the state of salts, as the sulphate, phosphate, and carbonate of iron.—1. *Native Iron.* Natural malleable iron is a rare production of this globe,—nearly all that has ever been found upon it having come to us from the atmosphere. The meteoric ore differs very considerably from the terrestrial, native iron. Its colour is a light steel-grey, resembling platina; it is easily cut with the knife, and is flexible and perfectly malleable when cold. Specific gravity, 7·768. It occurs in large masses, sometimes of many tons weight, marked externally by impressions like those produced by the hands and feet upon a soft, plastic mass; also in small globular and filiform masses, disseminated through meteoric stones. Occasionally it presents imperfectly-formed octahedral crystals. A crystalline texture becomes visible, however, in cutting the large masses, and exposing the surfaces produced to the action of nitric acid, or allowing them to tarnish by heat. It invariably contains from 3 to 12 per cent. of nickel, and often traces of cobalt, neither of which metals have ever been found alloying terrestrial native iron. Meteoric iron is contained in all meteoric stones; in some it exists in a very feeble proportion, in others, it forms one quarter of their weight; and again in others, it constitutes nearly the entire mass; while the largest masses of it ever found consist of it wholly, without the smallest mixture of foreign matters.—2. *Magnetic Iron ore*, or *Oxydulated Iron*, is of an iron-black colour, more intense than belongs to metallic iron; its powder is of a pure black. It occurs crystallized, in the form of the regular octahedron, which is its fundamental form; it usually, however, presents itself in large lamelliform masses, with distinct octahedral cleavages, in granular concretions, or compact. It is brittle, has the hardness of felspar, and a specific gravity of 5·094. It exerts a decided action on the magnetic needle; and certain specimens, especially of a compact variety, attract and repel alternately, the poles of a needle, according as we present the same point of a fragment of the ore to one or the other of the extremities of a needle. Its magnetic virtue strengthens by exposure to the air. The magnetic iron consists of 28·14 protoxide of iron, and 71·86 of peroxide of iron. It is infusible before the blow-pipe, but assumes a brown colour, and loses its attractory power, after having been exposed to a great heat. It is soluble in nitric acid, and may be obtained crystallized by fusing it, as often happens in the roasting of it, in furnaces, to effect its reduction. It occurs in primitive rocks, chiefly in gneiss, mica-slate, hornblende-slate, and chlorite-slate, and rarely in limestone, when it forms veins, beds, or even entire mountains. It also composes the chief ingredient of certain sands, which have been washed and deposited by the same currents which separated it from its original beds. The different varieties of this ore are exceedingly rich in metal, often yielding 80 per cent. of iron, and are everywhere explored, when found in sufficient quantities, and connected with abundance of fuel and facility of transportation. The present ore forms the best iron which is made for the manufacture of steel; and hence the employment of Swedish iron by the English for this purpose.—3. *Chromated Oxide of Iron* (*Chromate of Iron*) is found crystallized in regular octahedra, and massive. Lustre, imperfectly metallic; colour, between iron-black and brownish-black; streak, brown; opaque; brittle; hardness, the same with the preceding species; specific gravity, 4·498. Vauquelin and Klaproth make it consist of

Oxide of chrome,	43·00	55·50
Protoxide of iron,	34·70	33·00
Alumina,	20·30	6·00
Silica,	2·00	2·00

Alone, before the blow-pipe, it is infusible, but acts upon the magnetic needle, after having been exposed to the reducing flame. It is dissolved when heated with borax, to which it imparts a beautiful green colour.—4. *Specular Iron ore*, and *Red Iron ore*. This species, scarcely less interesting than the last in economical importance, presents many difficulties to the mineralogist, in consequence of the complicated forms of its crystals, and the diversified appearance of its compound varieties. It is crystallized in a great number of forms, whose fundamental figure is a slightly-acute rhomboid of 86° 10′ and 93° 50″, which may be derived from its crystals by cleavage. The general tendency of its secondary forms is to hexagonal prisms and irregular octahedra. Lustre, metallic; colour, dark steel-grey, iron-black; streak, cherry-red, or reddish brown; surface of the crystals frequently tarnished; opaque, except in very thin laminæ, which are faintly translucent, and show a deep blood-red colour; brittle; hardness, the same with the preceding species; specific gravity, 5·251. Its action upon the magnet is feeble; it never attracts iron-filings, or offers magnetic polarity. Besides occurring in distinct crystals, and in lamelliform and compact masses, with a metallic lustre, it also presents itself in reniform, botryoidal and stalactitic shapes, and earthy-looking masses, where, from the smallness of the individuals, no signs of the metallic appearance are discernible. These varieties have received distinct names, and have often been treated of, in mineralogical systems, as belonging to a distinct species, which, on account of their colour, has been designated *red iron ore*. But this distinction is now given up, as an uninterrupted transition has been noticed between all the varieties of the red iron ore and the crystalline specular iron. —5. *Hydrous Oxide of Iron*, and *Brown Iron ore*. The present is a species nearly parallel to the foregoing, in the quantity of iron it affords to society. It is very rarely observed in distinct crystals, more usually occurring in botryoidal and stalactical masses, consisting of closely aggregated fibres, in which respect it resembles the most common varieties of the specular iron. The crystals are very small, externally black and brilliant, and in the shape of right rectangular prisms. The general character of the species is as follows: lustre, adamantine; colour, various shades of brown, of which yellowish-brown, hair-brown, clove-brown and blackish-brown, are the most common; streak, yellowish-brown; brittle; no action on the magnet; scratched by felspar; specific gravity, 3·922. Besides occurring in crystals, and in globular stalactitic and fruticose shapes, it is found in masses whose composition is impalpable; sometimes, also, the particles are so slightly coherent, that the mass appears earthy and dull. It differs, chemically, from the specular iron, in containing a quantity of water, not merely interspersed through its substance by simple absorption, but intimately combined with it by chemical affinity.—6. *Arsenical Iron*, or *Mispickel*, is found crystallized in right rhombic prisms of 111° 12′ and 68° 48′. These are often terminated by dihedral summits, and liable to a large number of modifications. It also occurs massive. Lustre, metallic; colour, silver-white, inclining to steel-grey; streak, dark greyish-black; brittle; hardness, nearly that of felspar; specific gravity, 6·127. Its chemical composition is, iron, 33·5, arsenic, 46·5, and sulphur, 20. Before the blow-pipe, upon charcoal, it emits copious arsenical fumes, and melts into a globule, which is nearly pure sulphuret of iron. It is soluble in nitric acid, with the exception of a whitish residue. It sometimes contains a small proportion of silver.—7. *Axotomous Arsenical Pyrites;* a species differing from the preceding in the inclination of the lateral faces, which, in the present case, meet under angles of 122° 26′ and 57° 34′, and in specific gravity, which in this species is 7·228. It has not yet been analyzed, but is believed to consist wholly of iron and arsenic.—8. *Iron Pyrites* is the most universally distributed of all the ores of iron, and, from its yellow colour and metallic aspect, is the substance which is so frequently mistaken, by ignorant people, for gold. It is not uncommon to find it regularly crystallized, though the dimensions of the crystals are rarely such as to render them very conspicuous. The prevailing figure among its crystals is the cube, parallel to whose faces they may be cleaved, as also parallel to the sides of the regular octahedron. The last is assumed as the primitive form of the species by most mineralogists, as leading to an explanation of the numerous secondary forms with the greatest simplicity. The most frequent of these secondaries are the cubo-octahedron, the pentagonal-dodecahedron, and the icositetrahedron. The surfaces of the crystals are sometimes smooth, and sometimes alternately streaked. Fracture, conchoidal, uneven; lustre, metallic; colour, passing through a few shades of a characteristic bronze yellow; streak, brownish-black; brittle; hardness, such as to be impressed with the knife, and scratched by felspar; specific gravity, 4·98. The crystals are liable to be much grouped, often penetrating each other so as to form globular masses. It occurs, also, in granular, columnar and impalpable masses; and often cellular, in consequence of forming upon crystals of galena, which have subsequently become decomposed. Iron pyrites consists of iron, 45·74, and sulphur, 54·26. In the exterior flame of the blow-pipe, it becomes red upon charcoal, the sulphur is driven off, and oxide of iron remains. In heated nitric acid, it is partly soluble, and leaves a whitish residue. Some varieties are subject to decomposition, when exposed to the action of the atmosphere. With regard to its geological relations, much diversity obtains; it constitutes beds by itself of considerable magnitude, in gneiss, mica-slate, and primitive argillite, and is often an important ingredient of those beds which contain ores of lead, iron, copper, &c. It is frequently mixed with coal seams and the beds of clay which accompany them. It is also met with, in considerable quantities, in veins, associated with blende, arsenical iron, galena and copper pyrites. It is found, likewise, with ores of silver, and is contained in many organic remains, both of vegetable and animal origin.—9. *White Iron Pyrites* differs from the preceding species in its crystalline characters, as well as in some other respects, though, in chemical constitution, the two appear to be perfectly identical. Its crystals are in the form of modified rhombic prisms, and of very flat crystals, having the appearance, at first sight, of dodecahedrons with triangular planes, but which, however, are macles, consisting of similar portions of five crystals. The primary form is a right rhombic prism, of about 106° and 73°, parallel to the planes of which it yields to mechanical division. The faces of the crystals are deeply streaked, in a vertical direction. Lustre, metallic; colour, pale bronze-yellow, inclining to grey; streak, greyish-black; hardness, equal to that of felspar; specific gravity, 4·67. It occurs massive, and in various imitative shapes, in consequence of which, and the composition of its crystals, it has been distinguished into several varieties, as *radiated pyrites*, *spear pyrites*, *cock's-comb pyrites*, *hepatic pyrites*, and *cellular pyrites*. Before the blow-pipe, it behaves like common iron pyrites. Some of its varieties are peculiarly subject to decomposition. It is less frequently met with in nature than the preceding species, though very often found accompanying it. It occurs more frequently in rocks of the coal formation, and in strata of clay.—10. *Magnetic Iron Pyrites* is rarely seen in well formed crystals. Count Bournon describes it as occurring in irregular six-sided prisms. In general, it is massive and foliated, or fine granular. Lustre, metallic; colour, intermediate between bronze-yellow and copper-red; streak, dark greyish-black; subject to tarnish; slight action on the magnet; brittle; hardness, considerably inferior to that of common iron pyrites, or that of white iron pyrites; specific gravity, 4·63. It consists of iron 62·77, and sulphur 37·23. It occurs in beds, along with other minerals, usually in primitive rocks.—11. *Phosphate of Iron*, or *Vivianite*, occurs crystallized, in the form of a right oblique-angled prism of 125° 18′ and 54° 42′, which is that of the primary crystal. The crystals are long and slender for the most part, though generally very small. They are attached to their gangue by one of their broad lateral planes, or occur in aggregated groups. Lustre, pearly, approaching to metallic on certain faces; on others, vitreous; colour, pale blackish-green, sometimes approaching indigo-blue; streak, bluish-white; the powder produced by crushing the mineral in a dry state, is liver-brown; translucent, and rarely transparent; sectile; thin laminæ are flexible; specific gravity, 2·66. It also occurs massive, in small, reniform and globular shapes, and imbedded nodules; also in superficial coatings of dusty particles. The earthy varieties are dull, opaque, meagre to the touch, and light. Their colour, on first exposure to the light, is greyish, yellowish, or greenish white, or some pale tinge of blue; but it soon passes to a dark indigo-blue. In two varieties of vivianite (a friable one analyzed by Klaproth, and a crystallized one from Bodenmais in Bavaria, by Vogel), the following chemical composition was discovered:—

Protoxide of iron, . .	47·50 .	41.00
Phosphoric acid, . .	32·00 .	26·40
Water, ...	20·00 .	31·00

It decrepitates before the blow-pipe, but melts, if first reduced to powder, into a dark-brown or black scoria, which moves the magnetic needle. It is soluble in dilute sulphuric and nitric acids. It occurs in a variety of geological situations. The crystals are found in copper and tin veins, and sometimes in greywacke accompanying native gold; also in basalt and trap rocks. The earthy and massive varieties are imbedded in clay, and often accompany bog iron ore.—12. *Arseniate of iron* occurs in small cubic crystals, which are either unmodified, or have their alternate angles or their edges truncated. Lustre, adamantine, not very distinct; colour, olive-green, passing into yellowish-brown, bordering sometimes upon hyacinth-red and blackish-brown, also into grass-green and emerald-green; streak, similar to the colours; translucent on the edges; rather sectile; scratched by fluor; specific gravity, 3·00. According to two analyses, it consists of

Oxide of iron, . . .	45·50 .	48·00
Arsenic, ...	31·00 .	18·00
Oxide of copper, . .	9·00 .	0·00
Silica, ...	4·00 .	0·00
Carbonate of lime, . .	0·00 .	2·00
Water, ...	10·50 .	32·00

Exposed to a gentle heat, its colour is changed into red. In a higher degree of temperature, it intumesces, gives little or no arsenic, and leaves a red powder. Upon charcoal, it emits copious fumes of arsenic, and melts, in the inner flame, into a metallic scoria, which acts upon the magnetic needle. It principally occurs in veins of copper ores, traversing the older rocks.—13. *Carbonate of Iron*, or *Spathic Iron ore*, occurs crystalline and massive. Its crystals are acute rhomboids, sometimes perfect, or only having the terminal angles replaced, six-sided prisms, and lenticular crystals. They are very easily cleavable, yielding obtuse rhomboids of 107° and 73°. Lustre, vitreous, inclining to pearly; colour, various shades of yellowish-grey, also into several kinds of yellow, white and red; streak, white; translucent in different degrees; brittle; hardness, nearly identical with that of fluor; specific gravity, 3·829. It occurs massive, in broad, foliated and granular masses; also in fibrous botryoidal shapes, whence it has received the name of *spherosiderite*. Two varieties of this species, 1. the spherosiderite, and 2. a cleavable variety, have yielded to Klaproth,

	(1.)	(2.)
Protoxide of iron, . .	63·75 .	57·50
Carbonic acid, . .	34·00 .	36·00
Oxide of manganese, .	0·75 .	3·30
Lime, ...	0·00 .	1·25
Magnesia, ...	0·52 .	0·00

Before the blow-pipe, it becomes black, and acts upon the magnetic needle, but does not melt. It colours glass of borax green. It is soluble with difficulty in nitric acid, particularly if not reduced to powder. On being exposed to the air, it is gradually decomposed: first the colour of the surface becomes brown or black; afterwards, also, the streak is changed into red or brown; hardness and specific gravity are diminished; and even the chemical constitution is altered, the whole being converted into hydrate of iron. It frequently occurs, along with carbonate of lime, in veins and beds, in primitive rocks; also in metalliferous veins, accompanied by galena, gray copper ore, and iron and copper pyrites. —14. *Oxalate of Iron*, or *Humboldtine*, is an ore of iron found near Berlin, in Bohemia, in a moor-coal, or friable lignite. It consists of protoxide of iron 53·56, and oxalic acid 46·14. It is supposed to owe its origin to the decomposition of succulent plants. It occurs in small flattish masses, of a light yellow colour; is soft, yielding to the nail, and of the specific gravity of 1·3. By rubbing, it acquires resinous electricity. It decomposes easily on live coals, giving out a vegetable odour. It is insoluble in boiling water and alcohol.—15. *Sulphate of Iron*, or *Copperas*. This salt is not frequently found in nature, in distinct crystals, but usually occurs in stalactitic, botryoidal and reniform masses, and occasionally pulverulent. The crystals are in the form of right oblique-angled prisms, considerably modified by replacements; fracture, conchoidal; lustre, vitreous; colour, several shades of green passing into white; streak, white; semitransparent and translucent; brittle; hardness, that of gypsum; specific gravity, 1·83; taste, sweetish-astringent and metallic. It consists of

Oxide of iron, ...	27·7
Sulphuric acid, ...	28·9
Water, ...	45·4

It is easily soluble in water, and the solution becomes black on being mixed with tincture of galls. If exposed to the open air, it soon becomes covered with a yellow powder, which is persulphate of iron. Before the blow-pipe, it becomes magnetic, and colours glass of borax green. In most instances, it is produced by the decomposition of other minerals, particularly of iron pyrites and magnetic iron pyrites; and the crystallized varieties are rarely found, except in those places where artificial heaps of these substances have been formed. It is also found incrusting slate rocks, and dissolved in the waters of certain mines.

All iron when exposed to humid air becomes rusty, or, in the language of chemistry, attracts oxygen from the atmosphere, and is converted—at least upon its surface—into oxide of iron, and in process of time will become oxydized throughout its whole substance; for the rust of iron is a regular oxide, and iron has so strong an affinity for oxygen that it is matter of difficulty to prevent this oxidation going on. This at once shows why native metallic iron should be scarce, and why most of the ores of that metal that are met with should be oxides. The oxides of iron seldom present a metallic appearance; they vary in colour from bright red to reddish-yellow or bright yellow, and are occasionally nearly black; and this metal is so generally disseminated over the surface of the globe that these oxides frequently give a tint of colour to the whole soil, rendering it brown, yellow, or red. In these cases the iron exists in such small quantities as to render its collection for useful purposes impossible. What are called iron-mines are immense collections of the ore of iron forming in masses usually stratified in a nearly horizontal direction, and which are frequently from six to twelve or fifteen feet in thickness, and of great extent. These mines, or formations of iron ore, are very common, and exist to a greater or less extent in all countries, particularly such as are mountainous; but the ore is useless without the proximity of a plentiful supply of fuel to reduce it, and of limestone which is necessary for a flux to promote the flowing of the metal when produced from its original matrix. On this account many valuable deposits of iron cannot be worked, for iron is now sold at so cheap a rate as not to admit the expense of transporting any of the necessary constituents for its formation to any very considerable distance, and those mines only work to advantage in which the iron ore, limestone, and wood or coal, are found on the same location,—which is by no means an uncommon case.

Iron has a strong affinity for most if not for all the natural combustibles, and in a hot state will combine readily with them. It also combines or mixes with most of the other metals, forming alloys that alter the character of the metal very essentially. In proof of this, heat a bar of iron in a smith's forge to nearly white, or what blacksmiths call *a welding heat*, and on rubbing it with a stick of brimstone or sulphur, the iron and sulphur will simultaneously melt and fall down in drops, which become hard on cooling, but on examination will be found to be neither iron nor sulphur, but a combination of the two, called by chemists *sulphuret of iron*, which is hard and brittle, without metallic lustre, and in fact possessing none of those properties that render iron valuable. It might be supposed that on heating this compound again, the sulphur would be evaporated and driven off; but this will not be the case: the combination is too strong to be dissolved by such means, and the iron is spoiled for all ordinary purposes. Iron combined naturally with sulphur is a very common mineral production, found constantly in iron and other mines, and known generally by the names of *iron* or *martial pyrites*, *mundic*, and *marcasite;* and it is one of the most bright and beautiful minerals, being crystalline with metallic lustre, and a colour between brass and gold, so that it has frequently been supposed by the ignorant to be this latter metal. This mineral, when it occurs, must be carefully picked out of the iron ore before it is worked, as a small quantity of it will deteriorate a large quantity of iron.

Carbon, or the pure material of coal, unites with iron in the same manner as sulphur, though to a less extent, and is less detrimental to it; and as the reduction of iron-ore consists in filling a very tall furnace, built for the purpose, with alternate layers of iron-ore, limestone, and fuel, which soon gets into a state of ignition by the fire previously made, and urged by powerful bellows or other blowing machinery, so that the iron becomes reduced by being deprived of its oxygen, and trickles down through the ignited fuel, it comes into constant contact with carbon while both are at a very high temperature, and a union consequently takes place. In this manner, however, all iron is reduced in the first instance; and being obtained in a fluid or molten state, the bottom of the furnace is tapped, or a hole opened into it at stated periods, to permit the fluid iron to flow out. When cold, it first assumes the character of metallic iron; but it is unfit for general use, being white and almost crystalline in its fracture when broken, exceedingly brittle, and so hard that no file or other tool will touch it. In this state it is thick or viscid while hot, and does not flow or run easily, and is therefore unfit for the purposes of the iron founder; but large and heavy castings that require to be hard, and have no turning, drilling, or other operations of workmanship to be performed upon them, are often formed of this iron, which, on its first production, is called *crude* or *forge iron*.

From what has been already stated, it will be evident that the fuel used for the reduction of the iron will have considerable influence upon it. Hence the extensive use of coke in its preparation. See article Coke.

From the above slight sketch of the manner of producing iron it will appear that it is constantly obtained in a melted or fluid state in the first instance; yet it is obvious that it is met with in two distinct forms called *bar* or *malleable*, and *cast-iron*, the characters of which are as distinct as two separate metals. Malleable iron is manufactured into long square or rectangular pieces called *bars*, or long cylinders called *rods*, or flat plates called *sheet iron*. If good, it should be characterized by its toughness, ductility and capability of bending, its strength, its power of receiving and retaining a highly reflective polish, its fibrous texture, the facility with which it rusts or combines with oxygen, by its capability of welding when highly heated, so that two pieces may be united by hammering and made as strong as if they had never been separate, and by its resistance to fusion by heat. Cast iron, on the contrary, has no ductility and but little toughness, and will only admit of bending in a slight degree without breaking; it is very inferior in strength to malleable iron; it may be made smooth and polished, but will never have a highly reflective surface; it has a granular instead of a fibrous texture; rusts or combines slowly with oxygen; cannot be united by welding; and fuses and becomes liquid when exposed to a high heat. The iron in both cases is the same, and these extraordinary differences of character appear to depend entirely on the quantities of carbon and oxygen which have combined with the metal at the time of its reduction. Iron in its malleable state is believed to be pure or free from alloy; and the more pure it is, the more perfect the metal will be; but cast iron is alloyed or mixed with carbon and oxygen, and the different proportions of these lements that are present will sensibly affect the uality of the metal. Cast iron is not, therefore, trictly speaking, iron, but a carburet of iron ombined with some oxygen.

The obvious process, therefore, for procuring nalleable iron, is to refine or purify the imperfect arburet of iron that is obtained from the ore by he first process of reduction above described, by aking from it the carbon it had imbibed. This s done by melting the crude or forge iron a econd time in a reverberating furnace, or one o constructed that the iron shall be exposed to free current of air, and shall be subject to all he heat of the fuel without being in contact vith it. So soon as the iron is fused, it is kept onstantly stirred and moved about by iron rods, o as to constantly expose new surfaces to the eat and air, which process is called *puddling*. y this process any carbonaceous matter the ron may have contained is burnt and consumed, nd other portions of iron combining with the xygen of the air, the iron shortly loses its luidity and becomes ropy and tenacious like ough, and the workman, judging from his ex- erience when this change has been sufficiently rought, removes the mass of iron from the fur- ace, and places it on a large anvil where it eceives a few blows from a very heavy forge- ammer worked by machinery, and which forms t into the shape of a square bar of from two to hree feet in length. The blows of this hammer ot only form the bar, but render the mass more ense and compact, and drive off all the oxide of ron that was formed during the puddling pro- ess. This flies off in all directions under the ammer, forming scintillating sparks of great rilliancy and beauty.

Rolling-mill.—The short bar while yet in a glow- g heat is speedily carried to the forming rollers, d if a square bar is desired, is presented to the quare opening, and carried forward by the revolu- ion of two cast iron rollers. If a smaller bar is re- uired, the hot piece is returned back again through he next opening, and afterwards through the next naller, and so on, until it is reduced to the required ize. If a round rod of iron is required, the piece is like manner presented to and passed through the ound openings; and thus the hot bar which was ori- inally only 30 inches in length, is extended to 10 or 12 et, or even more, and afterwards cut by shears to e required length of the bar. All bars of iron are ow formed by passing them between rollers of this ind, and of course iron-mills must possess a number f such rollers suited to the sizes and forms of the on to be produced; because, by altering the inden- ations in the rollers, bar-iron of any form may be roduced, and it is in this way that railroad iron of articular forms is made, or iron mouldings for hand- ils and other purposes. The largest indentations e placed near the ends of the rollers, and the naller ones near their centres, in order to preserve e strength of the rollers. For the production of eet and hoop iron, the rollers are quite smooth, d without any indentations; but their general con- ruction is the same in all cases. They are sup- rted by two very strong cast iron side frames, ited to a cross piece that is buried in the ground d so fixed as to insure the stability of the whole machine. The rollers and their necks or gudgeons are turned in a lathe to insure their being perfectly cylindrical, and the necks turn in brass bearings to diminish friction. Two strong screws act upon the tops of the brasses of the upper roller, for the purpose of forcing the two rollers into contact with each other; but in rolling sheet or hoop iron these screws are relaxed, to permit the rollers to separate to a distance equal to the thickness of the article to be produced. The two rollers are connected together by two strong cast iron cog wheels, to insure their simultaneous motion; and the power of the water-wheel or steam-engine that produces their motion is connected to the lower roller only. Before the introduction of rollers into iron-mills, bar iron was shaped and produced by the blows of the forge-hammer alone, which occupied considerable time, and did not produce bars of the same uniformity as those now manufactured; but there is no doubt of the hammering process being the best for the production of good iron. The effect of repeated blows is to condense the iron and render it more compact and strong, and at the same time effectually drive off all oxide or carburet of iron, which are not so effectually removed by the equable and steady operation of mere pressure. The rollers, however, produce bars with a velocity that is astonishing to those unaccustomed to the operation, and give them a smooth and uniform appearance far superior to what the hammer produces; it is therefore the interest of the manufacturer to use rollers, notwithstanding the inferiority of the article, and the public, in general, are better pleased to get a handsome looking article for a low price, than to pay more for that which is really better but less pleasing to the eye. To compensate for the imperfect operation of the rollers, every bar passed through them should be reduced to a small size, and be then cut and doubled; a welding heat should then be applied to the two bars, when they are again to be passed between the rollers to be consolidated into a single bar and reduced to the required size. When two or more bars are heated, placed together and welded into a single bar by the rollers or hammer, the process is called *faggotting*, and the strength of the iron becomes much improved. Some manufacturers give an assurance that all their bars receive this treatment, which of course enhances the price of the iron; but it is very seldom resorted to in rods or round bars, and consequently they are considered less trustworthy than those of a square or rectangular shape.

When malleable or *wrought iron*, as it is generally called, is pure and good, it ought to bear bending even in the cold state without breaking; and the fracture when broken should exhibit a decidedly fibrous character, without much lustre. But if the iron is bad or brittle, it will not bear bending without breaking, and the fracture will be brilliant with a granular texture. Iron will not draw into a long continuous wire unless it is good and pure. The two varieties may, therefore, be very well exhibited and illustrated by breaking a piece of large iron wire, and a similarly sized cut nail, such as are now generally used. The wire must be bent backwards and forwards many times before it will give way, while the nail will break by being slightly bent. Notwithstanding the qualities of good iron should be always alike, yet it is so seldom met with, that three distinctive names have been adopted for it, viz: *tough iron*, and *cold short* and *hot short iron.* The tough variety—of which good Swedish iron is an example,—is tough and strong both in the hot and cold state. Cold short iron is approved by the smiths because it is easily welded and works freely while red hot, but is short or brittle when cold. Hot short, on the contrary, will not bear hammering while red hot, but is tough and tractable while cold, and is therefore useful for forming a number of small articles which do not need the aid of fire.

The value of bar iron in the market is generally known by the marks or names that are stamped on each bar, indicating the manufactory at which it has been produced, and the character of which soon becomes known to the trade. But a stranger who is unacquainted with these marks or signs cannot select iron with any certainty, without breaking the bars and examining the fracture; in addition to which some of the bars should be heated at their ends and struck with a hammer to avoid obtaining hot short iron, which is nearly useless in large works, unless to be used merely for bars to support weights or strains.

Scrap iron is a variety that is much approved for purposes where good iron is required. It derives its name from being formed of the waste scraps and bits of iron cut from bars, or produced in working them, as well as from all old iron that is saved. It is sold to the iron mills under the denomination of *bushel iron,* and is there put up into bundles of about half-a-hundred weight each, and tied and retained in form by hoop-iron. These bundles being placed in a proper furnace receive a welding heat, when they are brought under the forge hammer to weld or beat them into a mass and expel the rust or oxide, after which they pass through the rollers to be converted into bars. The iron being originally in small pieces, packed in all directions, the grain or fibre in this iron is more unequally dispersed and interlaced than in any other kind, and it produces a very superior bar when the scraps have been of good quality and are thoroughly incorporated.

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In 1823, this quantity had risen to 482,066 tons, and in 1830 it was further increased to 678,417 tons. But since 1830, in consequence of the introduction of the hot-blast by Mr. Nelson of Glasgow, rapid improvements have been made, and a most important saving of fuel effected. The results were thus stated:—In 1829, using coke and cold air, each ton of iron required for its production 8 tons 1 cwt. 1 quarter of coal. In 1830, using coke and heated air, each ton of iron was made with 5 tons 1 cwt. 1 quarter coal. In 1833, using raw coal and heated air, each ton of iron consumed in its production 2 tons 5 cwt. 1 quarter of coal. The saving in fuel is thus seen to amount to 72 per cent., and in Scotland the production of iron has risen from 37,500 tons in 1830 to nearly 500,000 tons in the last twelve months. There exists a prejudice against the hot-blast iron which is gradually abating, and a similar prejudice long prevented the use of black band ore, the value of which was discovered by Mr. Mushett so far back as 1801. In 1836, every iron work in Great Britain was visited by M. F. le Play, chief engineer to the Paris Board of Works, and he estimated the amount produced that year at 1,000,000 of tons. In 1840, Mr. Jessop found that there were 402 furnaces in England and Wales, in which 82, or 1 in 5, were out of blast; and out of 70 furnaces, 6, or 1 in 11, were out of blast. The quantity of iron made in 1840 was 1,343,400 tons; but in consequence of the commercial depression, this fell to 1,046,428 tons in 1842, being a depreciation of 22 per cent. He next directed attention to the effect of railways on the price of iron. In 1836 and 1837, Parliament passed 77 railway bills, of which 44 were for new lines, and the aggregate of extent about 1,200 miles, requiring a production of more than 500,000 tons of iron. The price of bar-iron, which had been £6 10s. per ton in 1834, rose to £7 10s. in 1835, and in 1836 to £11; but in 1837 the railway speculation had so far subsided, that only 15 acts for new lines were passed from 1838 to 1843,—the price of iron fell more rapidly than it had risen, and during this period iron could be sold with difficulty at less than half the price it commanded in 1836. The average price of iron at Glasgow in 1844, was £2 5s. 6d. per ton; in March 1845 it rose to £5; and in May to £5 10. This rise in price of 175 per cent. gave such stimulus to production, that the make of pig-iron, in Scotland, for the first six months of this year, was 260,000 tons, or at the rate of 520,000 tons per annum,—the production having been doubled since 1840. It is the opinion of iron masters that, since 1840, nearly all the increased production of iron in the kingdom has been drawn from Scotland. It appears that the demand created by the new railways, has stimulated every establishment to its utmost limits of production. But in order to add materially to the make of iron, a great many circumstances must concur. One of the chief difficulties arises from the workmen: skill is necessary, and the number of those properly trained is so limited, that they make demands for an enormous and disproportionate increase of wages on the first appearance of prosperity. Thus the cost of production seems to have more than kept pace with the rise of price. From this, combined perhaps with other causes, the amount of production in England for 1845 was only 917,500 tons, being 238,000 tons less than the production of 1840. From comparing several returns, it is clear that we have no reason to dread a failure of material, —some valuable and extensive fields of blackband ore having been recently discovered in Wales; but it seems not improbable that the Staffordshire iron-works will soon experience a deficient supply of coal. A new source of supply has been found in the refuse and waste of the lead mines of Weardale. The *rider* of the lead ore is a true carbonate of iron yielding from 25 to 40 per cent. Up to the beginning of the present century nearly two-fifths of all the iron used in this kingdom was imported from the north of Europe; but in 1806 this proportion had fallen to one-eighth, and foreign iron is now only imported for the manufacture of steel. Our exports, on the contrary, have so increased as to become an object of national importance:—

In 1827 we exported 92,313 tons, declared
value, ... £1,215,561
In 1845 . 351,278 . 3,501,895

The increase of our exports appears to be contingent on a reduction of price, and must, therefore, be materially affected by variations in the cost of production. Should the new railways stimulate a much larger production of iron, the quantity produced will greatly exceed the demand so soon as those railways are completed, and the prices will fall, perhaps to a lower point than has ever yet been witnessed. This will, probably, cause iron to be applied to many new purposes, and particularly to the construction of ships, fire-proof houses, and frame-work houses for export to new settlements. All this, however, must be the work of time.

IRON-WOOD,—botanically *Sideroxylon*. A genus of tender, ornamental, hard-timbered, ligneous plants, of the sapota tribe. The unarmed species, *Sideroxylon inerme*, is a white-flowered, ever-green shrub of the Cape of Good Hope, and was introduced to Britain toward the close of the 17th century. The stem is very branchy and about 5 or 6 feet high; the bark is dark brown; and the leaves are large, oval, and somewhat similar to those of the common bay, but smoother in surface and blunter at the end. Two other species, the woolly and the spiny, have been introduced from India and Morocco,—the latter regarded by some botanists as constituting a separate genus under the name of argania; and a number of other species are known. The bark of the spiny species, ground with oil, is used on the Malabar coast as a liniment for rheumatism; and its leaves and root, boiled in milk, are supposed to be an antidote to the bite of certain snakes.—Some other ligneous plants, particularly of the genus Metrosideros and order Myrtaceæ, popularly bear the name of iron-wood; and they and the sideroxylons derive this name from the compactness, hardness, and comparatively great specific gravity of their timber.

IRON WORK. Wrought iron work is performed by two distinct sets of workmen, called *blacksmiths* and *whitesmiths*. The blacksmith is the first to commence the business, and works exclusively at a fire urged by bellows, and called *a smith's forge;* he receives the iron, and after giving it its due heat in the forge-fire, fashions it into the required shape by blows of the hammer upon an anvil, and certain tools used in conjunction with it. If the work is so small and light that the smith can blow his own bellows, and hold his iron in the left hand, while he strikes upon it with a hand hammer in his right, he is said to work single handed; and the work produced is called single handed work. But in general the blacksmith has an assistant called his *striker*, who blows the bellows, and afterwards strikes upon the hot iron as soon as it is brought upon the anvil, with a heavy sledge-hammer used with both hands, and made to swing or revolve over his head in order to produce the most powerful blows. The blacksmith all the while turns the hot iron into its proper position for receiving the blow, and uses his hand-hammer to assist as well as to keep time or regulate the succession of blows, and occasionally to point out to his assistant where he wishes a particular blow to be given; and this is continued until the iron becomes so cold that the hammers have little effect upon it, when it is returned to the fire to be heated again. Each separate heating is called *taking a heat;* and thus smiths will often say they can do a particular job at a single heat, or at two or three heats. When the work is very large, the wind from two pair of bellows is frequently carried into the same fire, and in this case one striker will not be sufficient, but two or three are employed, and strike in regular succession,—a correct division of time being quite necessary, or they might injure each other as well as the tools they work with. The smith's anvil has a beak for turning round or curved work upon; and it has a square hole at the opposite end for putting iron over to be punched, and for holding the shanks of what are called *bottom tools*, or tools that fit on to the anvil; for if a piece of iron has to be rounded or made in the form of a moulding, it is done between top and bottom tools. These tools are of steel, and carry a concave mould of the form the iron has to take, made in two halves. The bottom tool is inserted in the hole in the anvil, and the and *hot short iron*. The tough variety—of which good Swedish iron is an example,—is tough and strong both in the hot and cold state. Cold short iron is approved by the smiths because it is easily welded and works freely while red hot, but is short or brittle when cold. Hot short, on the contrary, will not bear hammering while red hot, but is tough and tractable while cold, and is therefore useful for forming a number of small articles which do not need the aid of fire.

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In 1823, this quantity had risen to 482,066 tons, and in 1830 it was further increased to 678,417 tons. But since 1830, in consequence of the introduction of the hot-blast by Mr. Nelson of Glasgow, rapid improvements have been made, and a most important saving of fuel effected. The results were thus stated:—In 1829, using coke and cold air, each ton of iron required for its production 8 tons 1 cwt. 1 quarter of coal. In 1830, using coke and heated air, each ton of iron was made with 5 tons 1 cwt. 1 quarter coal. In 1833, using raw coal and heated air, each ton of iron consumed in its production 2 tons 5 cwt. 1 quarter of coal. The saving in fuel is thus seen to amount to 72 per cent., and in Scotland the production of iron has risen from 37,500 tons in 1830 to nearly 500,000 tons in the last twelve months. There exists a prejudice against the hot-blast iron which is gradually abating, and a similar prejudice long prevented the use of black band ore, the value of which was discovered by Mr. Mushett so far back as 1801. In 1836, every iron work in Great Britain was visited by M. F. le Play, chief engineer to the Paris Board of Works, and he estimated the amount produced that year at 1,000,000 of tons. In 1840, Mr. Jessop found that there were 402 furnaces in England and Wales, in which 82, or 1 in 5, were out of blast; and out of 70 furnaces, 6, or 1 in 11, were out of blast. The quantity of iron made in 1840 was 1,343,400 tons; but in consequence of the commercial depression, this fell to 1,046,428 tons in 1842, being a depreciation of 22 per cent. He next directed attention to the effect of railways on the price of iron. In 1836 and 1837, Parliament passed 77 railway bills, of which 44 were for new lines, and the aggregate of extent about 1,200 miles, requiring a production of more than 500,000 tons of iron. The price of bar-iron, which had been £6 10s. per ton in 1834, rose to £7 10s. in 1835, and in 1836 to £11; but in 1837 the railway speculation had so far subsided, that only 15 acts for new lines were passed from 1838 to 1843,—the price of iron fell more rapidly than it had risen, and during this period iron could be sold with difficulty at less than half the price it commanded in 1836. The average price of iron at Glasgow in 1844, was £2 5s. 6d. per ton; in March 1845 it rose to £5; and in May to £5 10. This rise in price of 175 per cent. gave such stimulus to production, that the make of pig-iron, in Scotland, for the first six months of this year, was 260,000 tons, or at the rate of 520,000 tons per annum,—the production having been doubled since 1840. It is the opinion of iron masters that, since 1840, nearly all the increased production of iron in the kingdom has been drawn from Scotland. It appears that the demand created by the new railways, has stimulated every establishment to its utmost smith must come as near to it as he can with safety.

The fuel of the smith's forge is of great importance, for the best iron may be spoiled and rendered incapable of working by a bad fire composed of coals containing sulphur, arsenic, lead, or other minerals that will combine with the iron at a high heat, and destroy its valuable properties. A small quantity of metallic lead thrown into a smith's fire will generally make the best of iron hot short, or in the smith's language, *rotten in the fire*, so that it will neither weld, nor bear hammering without breaking into pieces. Wood-charcoal is the safest fuel to use in respect to the iron, because it contains nothing that can injure it; but it is troublesome in its management to those unaccustomed to it, and throws off so many sparks as to make it disagreeable to work with, independent of its burning away very rapidly, and requiring the fire to be constantly supplied. Some varieties of pit-coal make an excellent forge fire, of which the Tanfield-moor coal of Northumberland, in England, is an example. It is a small and bad coal for household-purposes, but so excellent on the forge that it is eagerly sought after even by the blacksmiths of London and other distant places.

All work produced by the blacksmith is said to be forged, and he delivers it in the black or unpolished state in which it leaves the fire; this accounts for the name of this class of workmen. From the blacksmith it passes to the whitesmith, who has nothing to do with the fire, but files, polishes, and finishes the pieces for use; and the perfection of blacksmiths' work is to forge so neatly as to bring the pieces very nearly to their intended shapes and dimensions, so as to leave the whitesmith little more to do than to file away or otherwise remove the black external surface. In many instances one man goes through both operations; but in manufactories, where much is achieved by division of labour, it is found most advantageous to keep these branches distinct.—*Millington.*

IRONWORT. See ALL-HEAL (CLOWN'S).

IRRIGATING WHEELS. Hydraulic machines for lifting the water to be used in irrigation. The Persian wheel is one of the most celebrated of these machines. It was invented in the East, and was known and extensively used in very remote times, and won the general favour of the Moors in the middle ages, and continues to be somewhat generally employed in the south and east of Spain, and in other districts bordering on the Mediterranean. It consists of a series of earthen jars, attached to an endless rope, passing over a vertical drum, put into motion and kept in rotation by a trundle and cog horizontal wheel; and the moving power applied to the last is very generally one or more bullocks or mules. Two of the best modern varieties of this machine are described as follows by Mr. Cunningham in his 'Hints to Australian Emigrants,' and are recommended by him as well suited by their simplicity and power to the uses of Europeans in Australia:—

"The Malta wheel is 7½ feet in diameter, and has no rim, but instead of this, two sets of axle-spokes at about 2½ feet distance from each other, the opposites joined at the ends by cross bars of wood, with 7 frappings of a three-inch Sicilian grass rope over them, the frapping consequently passing completely round the wheel for the purpose of strengthening it, as well as of affording a powerful friction surface to the bucket band, thereby enabling a greater quantity of water to be brought from the well. The bucket band is composed of the same rope as the frapping, while the buckets are secured between the two band ropes by round pieces of wood passing through rings in the bucket hoops, and thence through the band rope on either side. The buckets empty the water toward the top of the wheel, whence it passes through among the frappings and spokes into the stone receiving-trough, under the wheel, which trough is 7½ feet in length, the same as the wheel's diameter. As the bight of the bucket band dips into the well, consequently the buckets come up full on one side, and descend empty on the other, the friction of the bucket band rope against the rope frapping of the wheel being the only security against the full buckets forcing backward the empty, by causing the band to slip round. At the upper edge of the receiving-trough at which the buckets descend, there is a wooden roller to prevent the empty buckets rubbing against the receiving-trough edge, which they otherwise would do. The water passes from the receiving-trough into the tank, where it remains until required for irrigation. Two mules, in alternate spells, are employed in the working of the wheel, and as they are kept without exercise in an adjoining house, the work is to them more a healthy exercise than a labour, and being blindfolded, they neither require a driver, nor grow giddy, however small the circle in which they move. The wells are necessarily of an oblong form, their length and breadth such as to allow of the free passage of the bucket band to and from the water. There is a hinged pane or check, fitting into notches in the spur wheel to prevent the latter turning backward, after the mule is withdrawn, from the overbalancing of the empty buckets by the full ones. This species of wheel, by its greater friction surface, is capable of raising water from a greater depth than any of the others similarly constructed; the distance from the top of a Malta wheel to the well water often exceeding sixty feet.—The high Smyrna wheel has two rims, one attached to the extremities of the axle spokes, and the other to the axle spoke rim (at about a three feet distance) by a series of rounded connecting cross spokes, over which the bucket band passes. By this arrangement, the buckets discharge themselves into the receiving-trough placed under the second rim a little above the wheel's axle, thus enabling the water to be raised at least four feet higher than by the Malta wheel, an object of greater importance in places where the irrigable ground is higher than could be reached by the Malta wheel water. Strong rough hair ropes are used for the bucket band in the Mediterranean; but strong coir ropes would answer equally well."

IRRIGATION. The fertilizing of land by means of extraordinary supplies of water. The methods of it are very various, the kinds and sources of the water employed are also pretty various, the principles on which it acts are somewhat diversified, and even the precise objects of it, as to the class and circumstances of the crops intended to be benefited, are not by any means uniform; yet—with the exclusion of the operations of warping, flooding, and horticultural watering, which the ordinary usages of language among cultivators do not regard as properly irrigatory—it amounts, in all cases and in all climates, to the simple imparting or maintaining of fertility by means of water.

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The Israelites, during their possession of Palestine—even though their land possessed no such aridity as that of Egypt, and was maintained in a high degree of fertility by natural watering from the clouds—found the practice of stated irrigation essential to the luxuriance or the requisite productiveness of most of their cultivated crops; and they watered their fields and gardens by means of canals or artificial rills of water, drawn from fountains, brooks, and rivulets, and distributable at pleasure over the neediest portions of the land. Allusions to these canals—commonly under the name of rivers in the authorized version—occur in many parts of the sacred volume, particularly Psalm i. 3; lxv. 10; Prov. xxi. 1; Isa. xxx. 25; xxxii. 2, 20; and Hos. xii. 11. The prophet Isaiah indicates sterility and desolation by the figure of "a garden that hath no water;" and the royal Solomon, in order to produce beauty and luxuriance in the home-views of his palace, "planted vineyards, made gardens and orchards, planted trees in them of all kind of fruits, and made pools of water, to water therewith the wood that bringeth forth trees." The fountains of many parts of Palestine, particularly copious and perennial fountains in tracts unwashed by rivulets, were valued as highly by husbandmen as by shepherds; "the upper springs and the nether springs" were esteemed by Caleb's daughter as great "a blessing" as the goodly "south land" which he had previously given to her; and the wells which the Israelites everywhere found in the land of their inheritance, quite as much as its wine and oil and honey, made that land appear to them incomparably richer than the fountainless Egypt which they had left.

The ancient Romans, though not urged by any necessity to irrigate regularly their arable lands, knew well the value of irrigating always their meadows and occasionally their corn-fields. Cato, the earliest of the Roman writers on agriculture, says to the Roman farmers, "Make water-meadows if you have water, and have dry meadows if you have no water." Virgil advises "to bring down the waters of a rivulet upon the sown corn, and, when the field is parched and the plants dying, to convey it in channels from the brow of the declivity." Pliny says that "meadows ought to be watered immediately after the vernal equinox, and the waters restrained whenever the grass shoots up into culm;" and he observes that the practice of irrigating destroys weeds, nourishes corn-plants, and serves instead of sarcling. Columella says, "Land that is naturally rich and is in good heart, does not need to have water set over it, and it is better hay which nature of its own accord produces in a juicy soil, than what water draws from a soil that is overflowed. This, however, is a necessary practice when the poverty of the soil requires it, and a meadow may be formed either upon a stiff or free soil, though poor when water may be set over it. Neither a low field with hollows, nor a field broken with steep rising ground is proper; the first, because it contains too long the water collected in the hollows; the last, because it makes the water run too quickly over it. A field, however, that has a moderate descent, may be made a meadow, whether it be rich, or so situated as to be watered, but the best situation is where the surface is smooth, and the descent so gentle, as to prevent either showers or the rivers that overflow it remaining too long, and, on the other hand, to allow the water that comes over it quietly to glide off,—therefore, if in any part of the field intended for a meadow, a pool of water should stand, it must be let off by drains, for the loss is equal either from too much water or too little grass."

Irrigation seems to have been practised from an ancient period in China, India, and Persia, upon nearly the same principles as in Egypt, Palestine, and Arabia. The Chinese historians, with the bold mendacity which characterises most of their archæology, even pretend that it was practised in "the Celestial Empire" at a period long prior to the known date of the general deluge. The Hindoos of the present day retain so pertinaciously the ancient practice as to make scarcely a single attempt at cultivation without the aid of artificial watering; and they very generally dig wells in the highest part of a field, raise water out of them in buckets by means of bullocks and a rope over a pulley, and distribute it in little channels through every part of the field. In all very hot countries, in fact, whether within the tropics or in the adjacent parts of the temperate zones, especially where the soil is arenaceous or otherwise irretentive, irrigation has, in all ages, been found essential to the success of almost every department of culture. Even the Mexicans practised it long before the days of Columbus, carefully and skilfully collecting the waters of the mountain torrents, and conducting them along proper channels to an affusion athwart their cultivated lands.

The practice of irrigation throughout the best parts of the south of Europe either outlived the decline of agricultural science at the fall of the Roman Empire, or was speedily revived. It is supposed by some authors, indeed, to have been first introduced to Spain, and reintroduced to the rest of Southern Europe, by the Moors; but it very probably was continued in some parts of England itself, and much more in France, and Spain, and Italy, from the time of the Romans. In the 11th century, or perhaps in the 10th, it was prosecuted in a very bold and profitable scale in Lombardy; and in the 13th century, the monks of that country were so celebrated for their knowledge of it as to be eagerly consulted upon it by the Emperor Frederick I. In modern times, it is regularly used for most crops throughout the greater part of Italy and Spain, and for potatoes, maize, madder, and sometimes vines, in a considerable portion of the South of France. "The waters of the chief rivers of the north of Italy, such as the Po, the Adige, the Tagliamento, and of all the minor streams, are employed in irrigation. There is no other country which possesses an extent of rich water meadows equal to that of the Lombards. The entire country from Venice to Turin may be said to be formed into one great water meadow: yet the irrigating system is not confined to grass lands; the water is conveyed into the hollows between the ridges in corn lands, into the low lands where rice is cultivated, and around the roots of vines. In the states of Lombardy, the water of all the rivers belongs to the States; in those of Venice, the government extends its claims to that of the smallest springs, and even to collections of rainwater; so highly, for the use of the cultivator, is water of every kind valued in the north of Italy. It is necessary, therefore, in Lombardy, to purchase from the State the water taken from the river; this may be taken by means of a canal through any person's grounds, the government merely requiring the payment of the value of the land to the proprietor, and restraining him from carrying his channel through a garden, or within a certain distance of a mansion. The water is sold by the government at a certain rate, which is regulated by the size of the sluice, and the time the run of water is used; this is either by the hour, half-hour, or quarter, or by so many days at certain periods of the year; the right to these runs of water is regularly sold like other property. Arthur Young gives an account of the sale of an hour's run of water through a sluice near Turin, which produced, in 1778, 1,500 livres. The rent of the irrigated lands in the north of Italy is, upon an average, more than one-third greater than the same description of land not watered."

The modern British practices of irrigation were not well known in England till about the close of the 17th century, and in Scotland till near the close of last century. Public attention was called to irrigation in 1610, by a work of Robert Vaughan, themselves into the receiving-trough placed under the second rim a little above the wheel's axle, thus enabling the water to be raised at least four feet higher than by the Malta wheel, an object of greater importance in places where the irrigable ground is higher than could be reached by the Malta wheel water. Strong rough hair ropes are used for the bucket band in the Mediterranean; but strong coir ropes would answer equally well."

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The irrigation of plantations of willows, poplars, alder, and other semiaquatic trees upon comparatively dry soils, and especially upon very dry ones, may always be found profitable in any part of Great Britain. Even the irrigation of vines, orange-trees, and olive-plants, by carrying water to their roots along furrows and other open ducts, in some parts of the South of Europe, is likewise found to be profitable. Yet the irrigation of any ordinary terrestrial forest-trees, either in Britain, or almost any where else in Europe, must generally be regarded as very perilous to the trees. Yet, says Sir John Sinclair upon the authority of the Statistical Account of Scotland, "Captain Shand of Templand in Aberdeenshire conducted water through his young plantations, and found that, when done with judgment, it was the cheapest and most effectual mode of encouraging the growth of trees."

The irrigation of corn-lands is universal within the tropics, and very general in all the lower latitudes of the temperate zones. One object of it in these regions is the deposition of alluvial matter; but the main object—except on soils which contain excessive proportions of hard gravel or silicious sand—is simply to supply the land with the quantity of moisture requisite for luxuriant vegetation; and so paramount and mighty is this object in the case of rice, the principal bread-stuff of the tropics, that, in order to obtain a good or even moderate crop, the soil must be kept constantly saturated during successive months of the season of greatest evaporation. This kind of irrigation—at least in most cases within the tropics—needs no collecting drains to convey away a surplus of water, but affords only such a supply as is wholly and constantly absorbed by the soil; it introduces the water either into alleys between narrow beds, or into furrows between drills; and the principal operations for it are the reducing of a field to the proper level or series of levels, the constructing of the carrier or main-duct to the highest part of the field, and the terminating of this duct in such a manner as to make it discharge its contents wholly and equally into the alleys or furrows.

The irrigating and the flooding of corn-lands have been considerably practised in some parts of Britain; and as the former of these practices as well as the latter can operate beneficially on British corn-lands, not at all by the supply of moisture, but solely by the deposition of alluvial and alkaline silts, the two practices have, in this department, been very generally confounded with each other, and described under the common name of irrigation. Sir John Sinclair, giving a summary account of these practices, yet speaking of them as one, says, "Mr. Scrymsoure of Tealing, a gentleman in Forfarshire, followed the practice for nearly fifty years, and with such success, that an enclosure, which had got into an exhausted state, was so enriched by it, that it preserved an uncommon degree of fertility for a succession of crops, (one of them wheat,) without fallow, lime, or marl, and with very moderate assistance from dung. The common method was very different. After watering for one or two seasons, they ploughed for oats, and by taking two or three successive crops, the soil was exhausted, and run out into weeds and poverty. Nothing else could be expected from such management. But in other parts of Scotland, irrigation was not only practised with considerable success, and for crops of grain, but immense quantities of wild oats, formerly prevalent, were completely extirpated, and for the destruction of which no other means were known, previous to the introduction of fallowing and of green crops. Water alone, however, without the addition of other substances, will not bring grain to perfection. Hence, though, from year to year, it may be applied to meadow and pasture grass with success, yet it cannot be repeated with advantage to corn, except at considerable intervals of time, or accompanied with manure. The system of irrigating for corn, seems likewise to have succeeded in Somersetshire, where a large tract of country, suffered to remain in pasture for two years, was during that time, at stated intervals, regularly flooded by a stream descending from the adjacent hills. It was then subjected to the following rotation of crops. 1. Wheat on the ley; 2. turnips; and 3. barley, and artificial grasses. The produce of grain was very considerable, namely, of wheat, from 40 to 50 bushels, and of barley, from 50 to 60 bushels per statute acre. In a late publication on the utility of water meadows, a question therefore is not improperly put, whether, upon particular soils, and under certain circumstances, irrigation might not produce similar effects upon wheat, and several other plants of the field and the garden, as upon herbage? The author adds, no reason can be assigned, why this valuable improvement should be restricted to the cultivation of grasses."

The irrigation of grass-lands has various modes of action, and is designed to promote the luxuriant growth of the meadow grasses. It is the kind of irrigation peculiarly suited to a cold and moist climate like that of Britain; and, in the current agricultural language of this country, it often bears exclusively, and always pre-eminently, the name of irrigation. It comprises a number of varieties,—all of which, however, may be classed into two, the flowing and the catch-work.—The flowing irrigation of grass-lands is practised upon flat or flattish meadows on the banks of streams.

The methods of it are diversified, and must adapt themselves to the precise form of the surface, and to the relative situation of this to the sources of the irrigation. But the most common require the land to be formed into beds or broad-ridges, similar to those of the old bleach-fields, so high as to let the intervals between them act freely as drains, and usually from 30 to 40 feet in width, and about 9 or 10 poles in length. The great object, jointly with the affusion of water, is to draw it off in rapid drainage; and more failures arise from the ridges not being sufficiently high, and from the slopes not being sufficiently steep, than from any other cause.—Catch-work irrigation may either be practised alone upon an entirely sloping meadow, or practised jointly with flowing irrigation upon a sloping part of a flat meadow. The methods of it are more diversified than even those of flowing irrigation, and require to be studiously adapted, in their details, to the precise configuration of the surface of each particular meadow. But, in a general view, it has been well described as follows: "After the water is brought from the original stream into a new cut, it is stopped at the end, on as high a level as the case admits of, by which the water is made to fill the trench, and run over at the side, and flood the land below it. But as the water would soon cease to run equally, and would wash the land out in gutters, it has been found necessary to cut small parallel trenches, at the distance of from 20 to 30 feet, to catch the water again,—hence the name originated; and the same plan of spreading or diffusing is continued until the water reaches the main drain at the bottom of the meadow." Catch-work irrigation is less expensive and performs its work with less water than flowing irrigation, and therefore very readily recommends itself to a preference; but it is by no means so efficient as flowing irrigation, and ought never to be adopted unless absolutely necessary.

Soils Suitable for Irrigation.—Almost any kind of soil, swarded with the meadow-grasses, may be profitably subjected to irrigation. Even meadowland which is naturally wet and tenacious, provided it undergo a system of efficient subsoil-draining, may be very advantageously irrigated. See the article DRAINING. Yet soils of a heavy clay description are generally the most unsuitable, soils of a loamy nature are but moderately suitable, soils of a peaty kind are often very suitable, and soils of very absorbent sand or gravel, or light and porous soils of any kind upon a thoroughly absorbent substratum, are always eminently suitable. Some of the most celebrated water-meadows on the banks of the Kennet have a very absorbent arenaceous soil; many of the best on the banks of the Wiltshire Avon have a massive and very porous subsoil of broken flints; and the foul-water meadows in the vicinity of Edinburgh, irrigated by the sewer-drainage of that city, rest upon the alluvial sands which were thrown up and deposited by the receding frith Forth. We are told that there are some soils i the vicinity of Standen in Berkshire, of so porou a quality as not to need any drains to empty th water-courses, and as in the course of a few hou to absorb all the water; and that these land though possessing scarcely six inches of moul above the gravel, are among the richest of wate meadows; the roots of the grasses readily pen trate them, and the earliest and sweetest herbag being produced. But, on the other hand, som of the best meadows in Gloucestershire and a Woburn have a clayey subsoil.

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Suitable Kinds of Water for Irrigation.—Water of widely different appearance, and from widel different kinds of sources, hold either in solutio or in fine and thorough mechanical mixtur many gaseous, saline, earthy and organic su stances which nourish and invigorate the grasses; and though any two specimens of water may totally differ from each other in the combinations and proportions of these substances, or even may scarcely possess any one or more of the substances in common, both may act with great power, though each in its own peculiar way, as irrigating fertilizers. Wherever the herbage on the margin of a stream is green, rich, and abundant, and the cresses and other aquatics within the stream itself appear to be strong and vigorous, the water, even though perfectly limpid or otherwise seemingly destitute of nourishment for grasses, may generally be regarded as holding in solution some substances well fitted to give luxuriance to meadows.

Waters much impregnated with iron are not, in general, considered to be favourable to vegetation; and such as have an astringent or chalybeate taste, or carry on their surface the ferruginous matter technically called 'iron-float,' are much disliked by professional irrigators. Yet though utterly incapable of anything but mischief by their metallic properties, whether these be cupreous, stanneous, or really ferruginous, they may, in some instances, possess such a preponderance of fertilizing substances as to be quite suitable for irrigation. The famous Presley meadow in Bedfordshire, so remarkable for its luxuriant growth of grasses, is so exceedingly ferruginous as to impart somewhat chalybeate properties to the water with which it is irrigated.

Waters impregnated with the contents of drainage from factories and chemical works may or may not be suitable for irrigation according to the particular nature of the substances in the drainage. Waters impregnated with metallic and acid substances from dye-houses, calico-works, and similar establishments, are absolutely poisonous to the grasses,—and, in some instances in which they have been allowed access to meadows, they have entirely destroyed the herbage; but waters seeming to be acidulous, or otherwise appearing to be of hurtful character, and yet containing an excess of carbonic acid and a considerable proportion of common salts and earthy carbonates, are really and even highly beneficial.

Waters tinctured with the juices which flow from peat-bogs, are generally regarded as either worthless for irrigation, or positively injurious. They are soon frozen; they convey no material nutriment; and they are commonly impregnated, or almost loaded, with such antiseptic substances as retard rather than promote vegetation. Yet some persons have alleged that a want of sufficient slope in the meadows, or of proper management as to the times, duration, and manner of the irrigation of them, may have occasioned some of the failures attending the use of bog-waters.

Sea-water, when employed in moderate quantity and within embanked marshes, is suitable for irrigation. Meadows near the mouth of the Severn, which are naturally irrigated with sea-water by the tide, are grazed instead of being mown, and are accounted the best possible pasture for such horses and cattle as require rest and spring physic; and salt marshes have been long and generally known to produce restorative and healing effects in diseased horses and in sheep either infected or threatened with the rot. Sea-water near the land, particularly in large estuaries and long bays, contains not only nutritive saline substances, but a considerable proportion of manurial organic matter, both animal and vegetable. Smith suggests that machinery should be employed to raise sea-water for irrigation.

Clear spring-water, especially from calcareous strata, and used in the vicinity of its sources, is generally more or less fertilizing. It is usually warmer than other waters, and on that account is eminently suitable for irrigation during severe weather in winter; it is not liable to be soon frozen; and it usually holds in solution a comparatively large proportion of some of the nourishing gases, particularly carbonic acid. A profusion of early succulent grass may frequently be observed over a distance of several yards from the spot or line at which clear spring-water from calcareous strata begins to overspread a patch of land. This kind of water, too, is less apt to render the grass gritty and unwholesome, and may therefore be used during a longer period than foul or muddy or discoloured water; and, on this account, even though known to be considerably less fertilizing, it is preferred by some irrigators.

Hard water which owes all or most of its "hardness" to the presence of gypsum—and this is by far the most common kind of hard water—is highly nutritious to some of the most important of the plants which constitute the succulent herbage of good meadows. See the article GYPSUM. "If," says Mr. Johnson, "river water contains gypsum, sulphate of lime,—which it certainly does, if the water is hard,—it must, under ordinary circumstances, on this account alone, be highly fertilizing to meadows, since all grasses contain this salt in very sensible proportions; for, calculating that one part of sulphate of lime is contained in every two thousand parts of river water, and that every square yard of dry meadow soil absorbs only eight gallons of water,—and this is a very moderate allowance, for many soils will absorb three or four times that quantity,—then it will be found that, by every flooding, more than 1½ cwt. of gypsum per acre is diffused through the soil in the water,—a quantity equal to that generally adopted by those who spread gypsum on their clover crops, lucerne, and sainfoin, as a manure, either in the state of powder, or as it exists in ashes."

River water, except in some very rare instances of an excess of ferruginous or peaty properties, is always suitable for irrigation; yet it necessarily varies in the degree of its fertilizing power with the mineral character of the basin, the comparative proportion of arable and pasture land drain-

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Suitable Kinds of Water for Irrigation.—Water of widely different appearance, and from widel different kinds of sources, hold either in solutio or in fine and thorough mechanical mixture many gaseous, saline, earthy and organic sub ingly offensive. This foul-water irrigation, therefore, though eminently good for the meadows, is bad for the air around them, and has actually deteriorated the property in their vicinity.

The Theory of Irrigation.—The mere supply of moisture, as has already been hinted, constitutes a main part of the fertilizing power of irrigation in hot countries. This supply, however, must be understood, not of water in its strictly proper or pure character, but of water in some of the ordinary conditions in which it is naturally supplied to plants. Pure water was regarded by the ancient Greek philosophers, and is still pronounced by many inconsiderate modern cultivators, as an universal and essential fertilizer; but when really pure, or when freed by distillation from foreign soluble matters, it has been proved, by the experiments of M. Saussure, M. Hassenfratz, and Dr. Thomson, to be utterly incapable of supporting vegetation, or at least to be unable to sustain plants to maturity or beyond the mere initial stages of their development. All water which supports vegetation, either, like rain, possesses an appreciable quantity of ammonia,—or, like the water of clear springs from calcareous strata, possesses a large proportion of carbonic acid,—or, like sea-water, is powerfully impregnated with nutritive salts,—or, like the water of brooks and rivers, is more or less charged both with organic matters and with nutritive mineral matters. The artificial supply of moisture to the cultivated plants of hot countries, therefore, is the supply not merely of pure water, but also of an equivalent for the ammonia contained in rains, or of the alimentary substances contained in the surface waters of the earth. The supply of nourishment held in solution by water, is a main reason, though not the only one, why the water for growing hyacinths and other bulbous-rooted flowering plants in glasses requires to be, from time to time, renewed. See the articles AMMONIA and FOOD OF PLANTS.

The washing away of the excretions of plants is probably a pretty general, though never a chief, fertilizing action of irrigation. These excretions, though harmless or positively useful to other plants, are generally injurious to the plants which produce them; and when, as in the case of the meadow grasses, they cannot be powerfully played upon by the chemical action of the atmosphere, and readily decomposed by the sun's heat, the sun's light, and the passing air, they may be advantageously washed out by the trickling current of irrigatory water. To ascribe all or most of the power of irrigation to this washing, is obviously absurd; and yet the language of a learned writer who so ascribes it may be advantageously quoted. "The increased fertility produced by warping on the Humber," he says, "may be accounted for from the excrementitious matter previously in the soil being washed out and carried away on the retreat of the warping waters. It is on the same principle that I am inclined to explain the effects of watering meadows, both according to the Swiss and the British method. When the water in Switzerland is laid upon a hay stubble, and floated slowly over the field, it will be found to soak into the surface as deep or deeper than the roots of the grass around which the excrementitious matter thrown out during the summer growth must have accumulated. But in consequence of the manner in which the lower rills are disposed in the field, the water thus soaked into the soil does not stagnate there, but passes on, carrying away, of course, part of the excretions with which it has come in contact. In the same way, when clear water is floated over a pasture field during the winter months, at alternate periods, a similar consequence must result." See the article EXCRETION OF PLANTS.

The protecting of the grasses from frost, during some parts of a severe winter, is another second-rate fertilizing action of the irrigation of water-meadows. Sir Humphrey Davy even thinks it a chief one, and says, "In very cold seasons, irrigation preserves the tender roots and leaves of the grass from being affected by frost. Water is of greater specific gravity at 42° Fahrenheit, than at 32°, the freezing point; and hence, in a meadow irrigated in winter, the water immediately in contact with the grass is rarely below 40°,—a degree of temperature not at all prejudicial to the living organs of plants. In 1804, in the month of March, the temperature in a meadow near Hungerford was examined by a very delicate thermometer. The temperature of the air at 7 in the morning was 29°; the water was frozen above the grass; and the temperature of the soil below the water in which the roots of the grass were fixed was 43°." But though this beneficial action may be maintained so long as the frost is not so severe as to arrest the current of the water, or to penetrate to the root-crown of the plants, it cannot exist, and may even be seriously reversed, in any severer frost; and considering how very shallow the current of water is which flows over the meadow, it must offer at best but a comparatively short and feeble resistance to the congealing power of frost. Practical irrigators, too, are rather averse than otherwise to let the water on the meadows when the temperature approaches the freezing point.

The maintaining of plants in a somewhat equable temperature during winter, or the protecting of them from alternations of congestion by frost and stimulation by heat, has probably quite as much to do as mere protection from frost with the fertilizing power of irrigation. Some writers and many farmers even push this idea to the length of ascribing decidedly beneficial effects to the irrigative cooling of the land, —at all seasons and in all countries, in summer as well as winter, and within the tropics as well as within Great Britain. Loudon, for example, says, "Water may also operate usefully in warm seasons by moderating temperature, and thus retarding the over-rapid progress of vegetation. The consequence of this retardation will be greater magnitude and improved texture of the grosser parts of plants, a more perfect and ample development of their finer parts, and, above all, an increase in the size of their fruits and seeds. We apprehend this to be one of the principal uses of flooding rice-grounds in the East; for it is ascertained that the rice-plant will perfect its seeds in Europe, and even in this country, without any water beyond what is furnished by the weather, and the natural moisture of a well-constituted soil."

The mechanical action of the irrigatory current of water, in exercising the plants, strengthening their organism, keeping their stems and root-crowns clear of obstruction, promoting the equable circulation of water and oxygen around them, and causing an equable distribution of all the soluble materials of their food, probably plays a considerable part in irrigatory fertilization. The differences of effect from the mere circumstance of fluence or stagnation in the water are prodigious; for while flowing water coaxes up the finest indigenous grasses of the climate, and renders them sweet and wholesome and nutritious and luxuriant, stagnant water starves, deteriorates, or kills all the good grasses, and evokes in their place a worse than worthless growth of carices, junci, and other coarse and innutritious sub-aquatic plants. See the article DRAINING.

The deposition of fine silt, whether of an argillaceous and calcareous nature upon silicious lands, or of a mixed nature containing a considerable proportion of organic matter upon almost any description of land, is generally a considerable part, and often a principal or main part, of the fertilizing power of irrigation. This part of the power, of course, is totally awanting in every instance in which the water employed is always perfectly limpid; but it is more or less present in irrigation with river-water, and is exceedingly conspicuous in irrigation with every sort of muddy or foul water. M. Lampadius found that when plants, placed in silica, alumina, or any other pure earth, were watered with pure water, they would not grow, and that, when watered with the liquid drainage of a dunghill, they not only grew but were luxuriant; and other experimenters have fully ascertained that plants absorb or secrete inorganic or incombustible principles very much in the proportion in which these are supplied by the water with which the plants are moistened,—that, for example, bean-plants grown in pure earth and supplied only with distilled water yield 3·9 per cent. of ashes or inorganic matter, bean-plants grown in pure earth and supplied only with rain water, yield 7½ per cent., and bean-plants grown in garden-mould and supplied with moisture in the ordinary course of garden vegetation yield 12 per cent. "Much more efficacy," remarks Mr. Stephens, "may be expected from the waters of large rivers, draining extensive tracts of rich improved soils, than from springs which receive no washings from surrounding lands, or from rivers running through tracts of mere mountainous pastoral districts of poor and unimproved soil; although, even in such districts, considerable quantities of enriching sediment may be expected from the waters of such rivers, if care is taken to have the meadow in a proper state for receiving the waters of the first flood after summer, which will wash down and carry along with them the droppings fallen from animals grazing upon the tracts of country which such rivers drain."

The supply of plants with carbonic acid and with nutritive salts and other nutritive matters held in solution, is, in every instance, an important part of the fertilizing power of irrigation. Such a supply, as we have seen, is more or less made by all the kinds of water suitable for irrigation; and constitutes the main fertilizing strength, in particular, of all limpid waters. A chief function of moisture in the soil, in all or any of the vastly diversified circumstances of subserviency to vegetation, is to hold the food of plants in a state of solution, in order that they may take it into their system through their absorbing spongioles; and when the carbonic acid, or the muriate of soda, or the sulphate of soda, or the chloride of sodium, or the dissolved organic matter, or any other principle of this food contained in irrigating water is scarce, or when the plants have a strong appetite or large capacity for that article of their food, the current of water, by constantly carrying away the drops and volumes from which the food has been abstracted, and constantly bringing drops and volumes containing fresh atoms of the food, cannot fail to be powerfully nourishing. See the article ABSORPTION OF PLANTS.

The Grasses of Irrigated Meadows.—Almost any of the good meadow and pasture grasses, either indigenous in Britain or suited to its climate, will flourish under proper management in irrigated meadows. When land already in grass is subjected to a system of catch-work irrigation, little or no interference may be made with its grasses, except to sow a few seeds on bare spots; for the grasses already on it will amply suffice to afford all the improved herbage which the irrigation is expected to stimulate or produce. But when the land to be irrigated has its surface broken or is ridged up with the spade or the plough, and when it is designed to be productive principally of hay, it must all be sown with the seeds of plants best suited to yield valuable and abundant crops, such as perennial red clover, rough-stalked meadow-grass, meadow Timothy-grass, and crested dog's-tail grass; and when pasture rather than hay is the object, rye-grass, white clover, and the meadow foxtail ought not to be omitted.

The soil of any ordinary meadow-land, when subjected to proper irrigation, produces of itself the particular grasses which are most congenial to its own constitution, to the degree of moisture applied to it, and to the special circumstances of its situation. Soils which consist of peat, resting on sand or sandy loam, with a substratum of chalk or gravel, generally produce, on the tops and sides of the ridges, the meadow foxtail, the brome grass, and the meadow fescue,—and, in the furrows and on the sides of the drains, the creeping bent, the hard fescue, the rough-stalked meadow-grass, and the woolly soft-grass. Soils of a sandy loam on a subsoil of clay, on the other hand, commonly produce the creeping-rooted soft-grass, the sweet-scented vernal grass, the crested dog's-tail, and the meadow barley.

The grass and the hay of irrigated meadows are almost universally known to be not so nutritious as those of ordinary pasture lands; yet they are not so much less so as is generally believed. Mr. George Sinclair, the distinguished experimentalist in the economical values and conditions of the several grasses, obtained from a certain weight of ryegrass, at the time of flowering, taken from a water meadow which had been fed off with sheep till the end of April, 72 grains of nutritive matter, and from the same weight of this grass, taken from a rich old pasture, which had been shut up for hay about the same time, 92 grains; and he obtained from the same grass from the meadow, which had not been depastured in the spring, 100 grains, and from the same grass, from the pasture which had not been fed off, 120 grains. Mr. Sinclair ascertained, too, that grasses forced in their growth by other and more stimulating influences than those of irrigation, such as the free use of either liquid or solid manures, are less nutritive than grasses grown in a less forced or strictly natural manner; and—selecting exactly similar specimens of ryegrass, of the same weight, the same age, and the same stage of growth—he found that four ounces of a very luxuriant patch, grown over a large deposit of cow-dung, yielded only 72 grains of nutritive matter, while four ounces of the crop immediately adjacent to this patch yielded 122 grains,—and that a quantity from an excessively manured soil yielded only 50 grains, while the same quantity from an unmanured part of the same soil yielded 95 grains.

The Evils and the Benefits of Irrigation.—Irrigation, though very simple in principle, is one of the most difficult operations of agricultural improvement,—peculiarly liable to be marred and perverted by ignorance or inconsideration,—and requiring, for its right execution in the majority of situations, not only a large amount of professional knowledge and experience, but a perspicacious adaptation of general principles to the peculiar circumstances of surface, soil, supply of water, and particular design. The consequence is, that a farmer who ventures to irrigate without engaging the special aid of a professional irrigator, is exceedingly apt to throw away his money and injure his land, and that even a farmer who employs an irrigator of second-rate skill or experience incurs a considerable risk of failure.

Serious obstacles to irrigatory improvement sometimes occur in a collision of interest between the owner or tenant of the meadow and the owner or tenant of the adjacent lands,—in the claims of different proprietors, or even of proprietors of different classes, such as landowners, canal-owners, millers, and manufacturers, upon the waters of the stream,—in the intermixture of estates at or near the meadow or the main-carrier duct,—in the aversion of the landlord to irrigation, or his positive conditioning against it in the lease,—and in the competing claims of the lands of the farm upon the farmer's limited means of effecting general improvement.

The herbage of a water-meadow, neither well-formed nor decidedly ill-formed, is at first improved, and afterwards becomes deteriorated; so that promising, at the outset, to compensate the costs of irrigation, it may eventually acquire such a coarseness in its proper grasses, and such an intermixture of rushes and other innutritious aquatics as to be ill-fitted to nourish cattle or positively disgusting to the palate. But this disadvantage arises from the undue flatness or bad management of the meadow; and in cases in which it does not readily or remuneratingly admit of permanent remedy, it may be mitigated from year to year by cutting its grasses early, and devoting them to hay.

The irrigation of meadows has been accused of rendering the air around them unhealthy. But such an effect, though seemingly indicated by the diffusion of malodour, is very doubtful even in the case of the extensive foul-water irrigation in the vicinity of Edinburgh; and it cannot, with even a show of reason, be affirmed of any cases of irrigation by either the clear water of springs, or the ordinary water of brooks and rivers. Water upon flat grounds must be stagnant in order to pollute the air; but in all its connexion with irrigated meadows, it passes briskly over the surface and is always in motion. Many of the best water-meadows, too, were originally pestiferous marshes, constantly soaked and putrescent under stagnant water; and in consequence of being drained below and irrigated above, have become as innoxious as the adjacent dry pastures or arable lands.

The chief advantages of meadow-irrigation—to adopt the words of Sir John Sinclair—are the following:—"First, with the exception of warping, it is by far the easiest, cheapest, and most certain mode of improving poor land, in particular if it is of a dry and gravelly nature; second, land when once improved by irrigation, is put into a state of perpetual fertility without any occasion for manure, or trouble of weeding, or any other material expense; third, it becomes so productive, as to yield the largest bulk of hay, besides abundance of the very best support for ewes and lambs in the spring, and for cows and other cattle in the autumn of every year; fourth, in favourable situations, it produces very early grass in the spring, when it is doubly valuable; and, fifth, not only is the land thus rendered fertile, without having any occasion for manure, but it produces food for animals, which is converted into manure, to be used on other lands, thus augmenting, in a compound proportion, that great source of fertility."

The profit of every well-contrived and well-conducted system of irrigation is considerable. One irrigator found that, in the course of two years, all costs were reimbursed, and the permanent value of the land considerably increased; another derived great advantage, in the very first season, from depasturing his irrigated land with sheep, cattle, and even cart-horses; another found that land previously worth not more than six shillings per acre was rendered by irrigation worth £2 15s. per acre to a farmer, and £3 10s. if let to the inhabitants of a neighbouring market-town; and a fourth found that land previously worth 10s. per acre, which had expended upon it irrigatory operations worth the annual interest of 15s. per acre, and was maintained in irrigation at the current yearly cost of 8s. per acre, acquired the permanent value of £4 per acre, or yielded as clear profit from the irrigation £2 7s. per acre. Even in Sweden, where the weather is both severe and changeful, and where the ground is covered with snow and ice during several months in the year, the first irrigated meadow ever formed in the province of Dalecarlia, amounting to 80 acres, and yielding only 1,150 stones of hay, produced in the second year after irrigation 11,250 stones,—in the third year, when great damage was done by the frost, 4,550 stones,—and, in the fourth year, when damage to probably one-third of the total value of the crop was done by the frost, 11,250 stones; and Mr. George Stephens, who formed this meadow in 1809, and gave the first public account of it in 1814, says in 1829, "The hay since the commencement of the irrigation is twice as good in quality; and I have not the least doubt, if the works are kept in proper repair, that the crops of hay and aftermath are double what they were at the time of the original publication of this account in 1814."

The Forming of Water-Meadows.—Every part of the surface of a water-meadow ought to have a sufficient inclination from the dead level to keep every drop of water which comes in contact with its upper side in constant motion till it arrives at its lower side or is absorbed into its soil. A surface everywhere in the form of an inclined plane, or of a series of inclined planes, is essential, not only to realize the advantages of irrigation, but to prevent the serious evils of the stagnation of water. Yet no directions for laying out such a surface can be given of a sufficiently comprehensive kind to apply to all meadows, or even to a considerable proportion. Almost any two pieces of land are in some respects so unlike each other, that a suitable plan for forming the one into a water-meadow must be somewhat modified before it be applicable to the other; and, in general, every meadow requires a design peculiar to itself, and must be formed after studied observation of its peculiarities of surface, and with special reference to the sources, the quantity, and the quality of the water with which it is to be irrigated. "It is not an easy task," remarks Mr. George Stephens, "to give an irregular surface the equal slope requisite for the overflowing of water. It is very necessary for the irrigator to have just ideas of levels; a knowledge of superficial forms will not be sufficient. Few people unacquainted with the art of irrigation, and the regularity of form which the adjustment of water requires, have any idea of the expense of modelling the surface of a field."

The common levelling instrument, in some one or other of its varieties, ought to be employed, not only in designing the general fall of the water from the river or other source to the meadow, but in planning and forming the carrier-duct and all other principal irrigatory channels. A breast-plough or tough spade is requisite for paring off sward. A line and reel are indispensable in making all the main alignments; and as the line is very generally used among the moisture, it ought to be thicker and firmer than the lines employed in gardening. The spades for digging or scooping out the ducts and trenches ought to be thin in the edges and sharp in the point, and to have a backward bend in the shaft. Water-scoops are needed for baling out water; and shovels, with bent shafts, are desirable for lifting out loose earth. Forks, with from four to six long, strong, sharp tines, are necessary for disentangling and eradicating reeds, sedges, and other matted and encumbering aquatic plants. A tool, called a crescent, somewhat similar in form to a gardener's edging-iron, but much larger and stronger, and with a somewhat long handle, is needed for cutting the alignments of the ducts and trenches in the sward. The chief of the other implements required are turf-knife, scythes, and barrows.

No legal hindrances to irrigation, such as the claim of other parties upon the water of the stream, the interposition of a point of land belonging to other parties, or an adverse condition in the lease, must exist; or if they exist, they must be removed. The meadow to be irrigated, unless it have a porous soil and a perfectly open subsoil, must be subsoil-drained. All the main feeders of the irrigation ought to be so constructed as to discharge their water somewhat rapidly and through a narrow opening into the subordinate feeders. The water for the irrigation must be drawn from the stream which yields it at a sufficiently high level to produce a free current over the meadow; and if such a level cannot be found at a point in the stream near the meadow, it must either be sought at some point higher up, or produced by the erection of a dam. If the soil of a flowing meadow be thirsty and absorbent, the surface of the whole, or of any requisite number of sections, may simply be levelled into an uniform inclined plane; but if the soil be even slightly retentive, the surface must be formed into a series of beds. When water is not abundant, and is distributed either wholly or partly in the catch-work manner, or in any other method upon a considerably sloping surface, it may be collected and redistributed at every three feet of its fall; yet if it owe a main part of its fertilizing power either to its silt or to its saline contents, it will, in this case, be deprived of much of that power before it reaches the lower portions of the meadow.

A fall of 8 inches from the stream to the meadow is sufficient for a distance of 100 yards, and a fall of 20 inches for a distance of 300 yards. The main conductor should be formed as straight as possible, and directed along the highest side of the meadow. The several ridges into which the meadow is divided should all be equal to one another in their slope toward the discharging drain; and the whole surface of each should have a gradual and uniform descent. If two or more sections of the meadow have such considerable swells as cannot be economically reduced to a common sloping level, each section must have its own separate or independent system of conductor, feeders, and ducts, for effecting a distribution adapted to the peculiarities of its surface. A sluice must be placed in the mouth of each main-conductor, both to exclude or admit the water in the ordinary management of the irrigation, and to divert the whole of a scanty supply to the neediest section or sections of the meadow in a season of drought. The stream which supplies the water, in some instances, makes such a deflection as to pass close along the foot of the rrigated meadow,—and it then naturally and admirably serves the purpose of a discharging drain; but, in all other instances, an artificial discharging drain must be cut along the lower end of the meadow, at such a level as readily to receive every drop of water the moment it arrives, of such a capacity as to contain the largest voume of water ever conveyed by the main-conductors to the meadow, and with such a fall and direction as to discharge its contents by the shortst practicable route into the stream.

The forming of the meadow into regular beds, nd the concurrent planning of the feeders, or horoughly distributing ducts, require great icety of execution, and must be carefully and ery variously adapted to diversities of soil and surface; and a complete system of them is needed for every area, whether entire meadow, large section, or small section, which is supplied by one main-conductor. "Where the soil is naturally dry, and the supply of water plentiful," says Mr. George Stephens, "the beds might be made 40 feet wide; but when the subsoil is naturally cold and impervious, their breadth should never exceed 32 feet, and in deep mossy soils even less. The feeders are made in the middle of the beds, always branching out at right angles from the conductors, except in cases where the ground falls two ways, when it will be necessary to make the feeders a few feet (or according to the fall of the ground) nearer the one drain than the other, or more on one side of the bed than the other. A bed 200 yards long will require a feeder, where it leaves the conductor, 20 inches wide, gradually decreasing in width to 12 inches at the farthest extremity; for the quantity of water becomes less and less by overflowing constantly over the sides. The earth taken out in forming the feeders is to be placed on each side, in such a regular manner as to form small banks with a gradual descent towards the drains. In forming the feeders, care should be taken to leave stops (small portions of solid earth) in them about 6 inches wide, at regular distances from each other, or according to the fall of the ground, to obstruct and keep up the water to a proper height, so that the whole length of the bed may be regularly watered without the assistance of notches." But when a water-meadow is well-formed, with a proper slope of the surface, and a proper gradual narrowing of the feeders, very few stops, and not one notch will be needed, and a pinned-down tough sod or one or two stones will fully serve the purpose of each stop. Drains must be made, between the feeders, in a reverse order, so as to gather up the water in the progress of its accumulation, and convey it without overflow to the discharging-drain; and in stiff or stiffish land upon a retentive subsoil, they must be at least 6 inches deep at the upper end, and must have a reverse width to that of the feeders, and must gradually increase in depth to nearly the level of the discharging-drain. "When the land is very unlevel, with a thin sward on it," says Mr. Stephens, "I would recommend every proprietor to plough the whole and take a crop of oats before forming it into a water-meadow; or if the sward of grass is strong enough to be lifted, to lift the turf and form the subsoil with the plough and spade, and lay the turf down again. In either of these cases, the beds should be raised about 12 inches in the centre." A small sluice in the side of every main conductor, for letting off any water which may escape through the shut head-sluice, is desirable, in order to secure perfect dryness on the meadow during the intervals of irrigation.

Meadow ground is sometimes so situated on both banks of a purling or trotting stream, as to admit of a system of irrigation on both sides from one point. Fence ditches extend along the sides and the lower ends of the two meadows, and fall at right angles upon the stream, and serve as discharging-drains to the irrigation; a system of feeders and draining-ducts, exactly similar to those of any ordinary bed-work irrigation, is constructed in each of the two meadows, in a direction parallel to the course of the stream; and two main-conductors are formed in a line with each other, at right angles with the stream, across the upper ends of the meadows to within 6 yards of the fence ditches. A wear is constructed across the stream to force the water into the main-conductor; and a sluice is constructed at the mouth of each main-conductor, to admit or exclude the water forced to it by the wear. When water is scarce or convenience requires, the one sluice can be open and the other shut, or the two meadows can be irrigated at different periods; and when water is abundant, both meadows may be simultaneously irrigated by keeping the two sluices open, or may be simultaneously kept dry by shutting the sluices of both main-conductors, and opening the sluices of the wear.

Catch-work irrigation may be executed on any one of a great diversity of plans, and even admits of a variety of good adaptations to almost any one considerable extent of surface. In some kinds of it, all the surface is disposed in uniform catch-work; in others, it is disposed in irregular and diversified catch-work; and in others, it is disposed partly in catch-work and partly in bed-work. In some, the upper part of the feeders act as drains; in others, the lower part of the feeders act as drains; in others, feeders and drains partly alternate as in bed-work; and in others, the only open drain for carrying away the water is at the lower side of the meadow. In some, the intervals between the feeders is comparatively great, and the gradient of the slope comparatively small; and in others, the intervals are comparatively small, and the gradient comparatively large. When the subsoil is porous, and the gradient of the slope is one foot in 20 or 30 feet, the beds may properly have a width of from 15 to 20 yards; and when the subsoil is retentive, and the gradient is less than one foot in 20 feet, the beds ought to have a width of more than 10 yards. In all the varieties of catch-work irrigation, when the water employed owes much of its fertilizing power to the presence of any kind of silt or of undissolved organic matter, the main-conductor of each division of the meadow ought to pass down the centre from the highest part to the lowest bed, so as to convey to every bed in the division an unused portion of the richest water, and therefore a somewhat fair proportion of the fertilizing sediment.

The Managing of Water-Meadows.—The proper management of water-meadows requires only a little attention and not much skill, and yet exerts a mighty control over both the quantity and the quality of their produce. All the works must be annually cleaned, and constantly kept in good order; all the surface ought, every year, to be minutely examined, and carefully cured of any inequalities in its slopes; and all the distributing ducts and stops, especially if the supply of water be not perfectly regular and uniform, ought, in every third or fourth day of each period of irrigation, to be narrowly surveyed. When the stream is always voluminous enough to give an ample supply of water, the management is easy, and consists, in a great measure, in simply fixing the sluices at such a height as to let in the exact quantity of water required; but when the stream is small, and sinks occasionally into an insufficiency for supply, and rises or falls in capability with every change in the humidity of the weather, the management is difficult, and requires both great watchfulness and much labour, and largely consists in diverting the water from one division of the meadow to another, or from one bed to another, according to the vicissitudes in the supply. One sad and frequent error in management, is to give one part of a meadow too much water and another part too little; another is, to allow the water to stagnate either generally in the subsoil or partially on the surface; another is, to let on the water at improper periods, or to keep it off at eminently suitable periods; another is, to allow the water to run too long at a time; another is, to let on the water a second time before it is properly dried after the first, or a third time before it is properly dried after the second; and another is, to allow the grass to stand too long before being mown.

The management of the water-meadows of Wiltshire, Hampshire, and Berkshire, has long been celebrated, and affords to irrigators in all parts of the kingdom far better hints than can be suggested by the most laboured theory. "In the autumn," says a succinct account of this management in the Quarterly Journal of Agriculture, compiled from Davis's Wiltshire, Driver's Hampshire, and other high authorities,—"In the autumn, the after-grass is eaten off quite bare, when the manager of the mead (provincially the drowner), begins to clean out the main drain, and the main carriage, and to 'right up the works,' that is, to make good all the carriages and drains which the cattle have trodden in, so as to have one tier or pitch of work ready for drowning. This is immediately put under water, whilst the drowner is preparing the next pitch. In the flowing meadows, this work ought to be done if possible early enough in the autumn to have the whole meadow ready to catch the first floods after Michaelmas: the water, being the first washing of the arable lands on the sides of the chalk hills, as well as of the dirt from roads, is then thick and good; and this remark as to the superior richness of the flood waters, is one that is commonly made in Berkshire and other parts of England. The length of the autumnal watering cannot be precisely stated, as much depends upon situations and circumstances; but if water can be commanded in abundance, the custom is to give meadows a 'thorough good soaking at first,' perhaps for a fortnight or three weeks, with an intermission of two or three days during that period; and continues for the space of two fortnights, allowing an interval of a week between them. The works are then made as dry as possible, to encourage the growth of the grass. This first soaking is to make the land sink and pitch close together, a circumstance of great consequence, not only to the quantity but to the quality of the grass, and particularly to encourage the shooting of new roots, which the grass is continually forming, to support the forced growth above. While the grass grows freely, a fresh watering is not wanted; but as soon as it flags, the water must be repeated for a few days at a time, always keeping this fundamental rule in view, 'to make the meadows as dry as possible after every watering, and to take off the water the moment any scum appears upon the land, which shows that it has already had water enough.' Some meadows that will require the water for three weeks in October, and the two following months, will not, perhaps, bear it a week in February or March, and sometimes scarcely two days in April and May. In the catch-meadows, which are watered by springs, the great object is, to keep the works of them very dry between the intervals of watering; and as such situations are seldom affected by floods, and generally have too little water, it is necessary to make the most of the water by catching and rousing it as often as possible; and as the upper-works of every pitch will be liable to get more water than those lower down, a longer time should be given to the latter, so as to make them as equal as possible. In Berkshire they first flood their water-meadows about Michaelmas; these are situated principally on the banks of the Kennet. The first flooding they deem the richest in quality: this they keep on the lands for about four days; then they dry them for about a fortnight; and then the water is let on for three or four days more. Those meadows which are the most readily dried are the most productive. There are none more so, in fact, than those which have a porous, gravelly, or broken flint bottom, from which the flood-water readily escapes, almost without drains. They begin to feed their meadows with sheep about the 6th of April, and continue feeding till about the 21st of May, when the meadows are again flooded for a crop of hay; the land is then flooded and dried alternately for three days until hay-time." —*Reports to the Board of Agriculture.—Stephens' Practical Irrigator.—Smith's Observations on Irrigation.—Brown's Treatise on Irrigation.—The Farmer's Magazine.—Quarterly Journal of Agriculture.—Journal of the Royal Agricultural Society of England.—Transactions of the Highland Society.—Dana's Muck Manual.—Sir John Sinclair's Code of Agriculture.—Sir John Sinclair's General Report of Scotland.—Lowe.—Doyle.—Young.—Loudon.*

IRRITABILITY. The contractility of muscular fibres, or a property peculiar to muscles, by which they contract, upon the application of certain stimuli, without a consciousness of action. This power may be seen in the tremulous contraction of muscles when lacerated, or when entirely separated from the body in operations. Even when the body is dead, to all appearance, and the nervous power is gone, this contractile power remains till the organization yields, and begins to be dissolved. It is by this inherent power that a cut muscle contracts, and leaves a gap, that a cut artery shrinks, and grows stiff after death. This irritability of muscles is so far independent of nerves, and so little connected with feeling, which is the province of the nerves, that, upon stimulating any muscle by touching it with caustic, or irritating it with a sharp point, or driving the electric spark through it, or exciting with the metallic conductors, as those of silver of zinc, the muscle instantly contracts, although the nerve of that muscle be tied; although the nerve be cut so as to separate the muscle entirely from all connexion with the system; although the muscle be separated from the body; although the creature, upon which the experiment is performed, may have lost all sense of feeling and have been long apparently dead. Thus a muscle, cut from the limb, trembles and palpitates a long time after; the heart, separated from the body, contracts when irritated; the bowels, when torn from the body, continue their peristalic motion, so as to roll upon the table, ceasing to answer to stimuli only when they become stiff and cold. Even in vegetables, as in the sensitive plant, this contractile power lives. Thence comes the distinction between the irritability of muscles and the sensibility of nerves; for the irritability of muscles survives the animals, as when it is active after death; survives the life of the part, or the feelings of the whole system, as in universal palsy, where the vital motions continue entire and perfect, and where the muscles, though not obedient to the will, are subject to irregular and violent actions; and it survives the connexion with the rest of the system, as when animals very tenacious of life, are cut into parts; but sensibility, the property of the nerves, gives the various modifications of sense, as vision, hearing, and the rest; gives also the general sense of pleasure or pain, and makes the system, according to its various conditions, feel vigorous and healthy, or weary and low. The eye feels and the skin feels; but their appointed stimuli produce no motions in these parts: they are sensible, but not irritable. The heart, the intestines, the urinary bladder, and all the muscles of voluntary motion, answer to stimuli with a quick and forcible contraction; and yet they hardly feel the stimuli by which these contractions are produced, or, at least, they do not convey that feeling to the brain. There is no consciousness of present stimulus in those parts which are called into action by the impulse of the nerves, and at the command of the will; so that muscular parts have all the irritability of the system, with but little feeling, and that little owing to the nerves which enter into their substance; while nerves have all the sensibility of the system, but no motion. After every action in an irritable part, a state of rest, or cessation from motion, must take place before the irritable part can be again incited to action. If, by an act of volition, we throw any of our muscles into action, that action can only be continued for a certain space of time. The muscle becomes relaxed, notwithstanding all our endeavours to the contrary, and remains a certain time in that relaxed state, before it can be again thrown into action. Each irritable part has stimuli which are peculiar to it, and which are intended to support its natural action: thus blood is the stimulus proper to the heart and arteries; but if, by any accident, it gets into the stomach, it produces sickness or vomiting. The urine does not irritate the tender fabric of the kidneys, ureters or bladder, except in such a degree as to preserve their healthy action; but if it be effused into the cellular membrane, it brings on such a violent action of the vessels of these parts, as to produce gangrene. Such stimuli are called habitual stimuli of parts. Each irritable part differs from the rest in regard to the quantity of irritability which it possesses. This law explains to us the reason of the great diversity which we observe in the action of various irritable parts: thus the muscles of voluntary motion can remain a long time in a state of action, and, if it be continued as long as possible, another considerable portion of time is required before they regain the irritability they lost; but the heart and arteries have a more short and sudden action, and their state of rest is equally so. The circular muscles of the intestines have also a quick action and short rest. The action of every stimulus is in an inverse ratio to the frequency of its application. A small quantity of spirits, taken into the stomach, increases the action of its muscular coat, and also of its various vessels, so that digestion is thereby facilitated. If the same quantity, however, be taken frequently, it loses its effect. In order to produce the same effect as at first, a larger quantity is necessary; and hence the origin of dram-drinking. The more the irritability of a part is accumulated, the more that part is disposed to be acted upon. It is on this account that the activity of all animals, while in perfect health, is much livelier in the morning than at any other part of the day; for during the night, the irritability of the whole frame, and especially that of the muscles destined for labour, viz. the muscles for voluntary action, is reaccumulated. The same law explains why digestion goes on more rapidly the first hour after food is swallowed than at any other time; and it also accounts for the great danger that accrues to a famished person upon first taking in food.

A property very similar to animal irritability, and usually sharing the same name, though depending on a different principle, resides in plants. Leaves, particularly those that are compound, exhibit the phenomena of it in a very singular degree; sometimes in the regular course of nature, and sometimes when placed in novel situations for the purposes of experiment. Each plant that displays a marked irritability, appears more especially affected by particular stimuli; so that some which exhibit the most singular degree of this quality, are perfectly unaffected by any stimulus, except that which seems to have been appropriated by nature to attain the especial object;—a proof to our minds, that we have only a faint glimpse of the purposes of the Great Author of Nature, or even of those general laws by which He regulates the operation of animated beings. It is rendered tolerably certain, by the experiments of Calandrini, that the display of irritability in the natural course of vegetation is owing, if not in all, at least in many cases, to the leaf itself, and not to the footstalk. This gentleman suspended vine leaves by a thread, after having previously separated them from the vine itself, and he found that they turned round to the light as they would have done had they not been separated from the stem. Leaves will become accustomed to particular stimuli, and will cease to be affected by them. M. Gerardin relates, that the celebrated Desfontaines conveyed in a carriage a plant of the *Mimosa sensitiva*, which is so remarkable for this property, as to derive its specific name from it, to a considerable distance, and that the first effect of the violent motion of the carriage was to induce the closing of the leaves, but after some time, no collapse of the leaves took place, although the motion continued with equal violence. Gerardin records a most singular fact relative to the *Mimosa sensitiva*, which he considers inexplicable. "I have seen," says he, "in one of my public exercises, in the central school of Vosges, and many were present besides myself, a young lady, who did not know this plant, on whom several of those pleasantries, so agreeable in society, were passed, that was urged to place her hand on it; after some hesitation, but being assured that no evil would result from the experiment, she passed her hand with some force over the plant which I had presented to her, without the least effect being produced on a single leaflet. Extremely surprised at this circumstance which I had then witnessed for the first time, I requested another lady to make a similar attempt, and immediately all the leaflets contracted." The experiment was repeated by the first lady with the same result as in the former trial. Probably this fact might be resolved, or at least supposed to be resolved, by its being referred to a difference in the electrical states of the two individuals who made the experiments; but as the solution would be as inexplicable as the fact itself, we have no hesitation in rejecting it, and avowing our entire ignorance of the cause which produces so extraordinary an effect. The causes inducing the contractions of different plants, and of the same plant, are very numerous. A touch of the hand, a scratch, heat, cold, strong smells, and many other stimuli produce this effect. By these means many experiments have been made on plants possessing irritability in perfection, and for that purpose the *Mimosa sensitiva* has been generally selected. Some stimuli seem, as we have hinted before, destined to produce certain determinate effects in certain plants, and are therefore applied by natural means; others again appear to have merely an accidental influence. Thus, the *Porliera hygrometrica*, a South American shrub, contracts its feathery leaves on the approach of wet weather, which it indicates with unerring certainty. The leaves of the *Onoclea sensibilis*, a species of North American *Filix*, when unfolding themselves, shrink on the least touch. The *Mimosa sensitiva*, so frequently mentioned, is affected by almost every means that can be applied. On the other hand, the *Dionœa muscipula* does not close its singularly constructed leaves until some animal has entered into its bosom, nor does it open until all motion on the part of the confined insect has ceased. Analogous facts have been observed connected with the genus *Drosera*, which is found in considerable quantity in this island. The most remarkable, however, of all those plants, which appear not to be affected by any specific agent for some definite event, is the *Hedysarum gyrans*, a native of Bengal, which is cultivated in our hothouses. It has trifoliate leaves, the central one of which is larger than the two others; they are all attached by articulations to a common footstalk. The central leaflet remains immoveable in a horizontal position during the day, and close to the footstalk during the night; the two smaller ones unceasingly describe an arc of a circle, the ascending of more rapid than the descending motion. If the regular motion be interrupted, as soon as it recommences, it goes on with increased vigour, and at length gradually subsides into its more natural movements. Many other examples of the same kind might be adduced, if our limits permitted us to enlarge on it. See the article Excitability of Plants.

ISACHNE. A perennial-rooted Australian grass, of the panic-grass tribe. It constitutes a genus of itself, and is specifically called *australis*, the southern. It grows 12 or 15 inches high; and takes its name of isachne from the equality of its glume. It was introduced to Britain about 27 years ago; but does not possess any interest for the farmer.

ISATIS. See Woad.

ISCHÆMUM. A genus of exotic grasses, of the villiflorous or sugar-cane tribe. Two perennial-rooted species and an annual—all about two feet high—have been introduced to British collections from India and Australia; and about a score of other species are known. Some one or more of them have the reputation of being good styptics, — hence the name *ischæmum*, which signifies "to stop blood;" but none appear to possess any value for the British cultivator. A hardy perennial-rooted species of andropogon, long ago introduced from the South of Europe, is also called ischæmum.

ISERTIA. A genus of ornamental tropical plants, of the madder tribe. The scarlet species, *I. coccinea*,—regarded by some botanists as a guettarda—is a magnificent evergreen shrub, of 10 or 12 feet in height, and carrying scarlet flowers in July and August. It was brought to Britain about 27 years ago from Guiana.

ISINGLASS. This substance is almost wholly gelatine, 100 grains of good dry isinglass containing rather more than 98 of matter soluble in water. It is brought principally from Russia. The belluga yields the greatest quantity, being the largest and most plentiful fish in the rivers of Muscovy; but the sounds of all fresh water fish yield more or less fine isinglass, particularly the smaller sorts, found in prodigious quantities in the Caspian sea, and several hundred miles beyond Astracan, in the Wolga, Yaik, Don, and even as far as Siberia. It is the basis of the Russian glue, which is preferred to all other kinds for strength. Isinglass receives its different shapes in the following manner. The parts of which it is composed, particularly the sounds, are taken from the fish while sweet and fresh, slit open, washed from their slimy sordes, divested of a very thin membrane which envelopes the sound, and then exposed to stiffen a little in the air. In this state, they are formed into rolls about the thickness of a finger, and in length according to the intended size of the staple; a thin membrane is generally selected for the centre of the roll, round which the rest are folded alternately, and about half an inch of each extremity of the roll is turned inwards. Isinglass is best made in the summer, as frost gives it a disagreeable colour, deprives it of its weight, and impairs its gelatinous principles. Isinglass boiled in milk forms a mild, nutritious jelly, and is thus sometimes employed medicinally. This, when flavoured by the art of the cook, is the *blancmanger* of our tables. A solution of isinglass in water, with a very small proportion of some balsam, spread on black silk, is the court plaster of the shops. Isinglass is also used in fining liquors of the fermented kind, and in making mock-pearls, stiffening linens, silks, gauzes, &c. With brandy it forms a cement for broken porcelain and glass. It is also used to stick together the parts of musical instruments.

ISMELIA. A genus of ornamental exotic

plants, of the chamomile division of the composite order. The Madeira species, *I. maderensis*, is a beautiful, striped-flowered, spring-blooming, evergreen undershrub, of about two feet in height; and was introduced to Britain about 13 years ago from Madeira. It loves a very light sandy soil.

ISMENE. A genus of beautiful, herbaceous, bulbous-rooted, tropical plants, of the amaryllis family. Three species were introduced to Britain upwards of 40 years ago from Brazil and Peru; and two species, about 10 years ago, from Lima and Florida. The Amancaes species, *I. amancaes*, comprises two varieties with respectively yellow and straw-coloured flowers; and all the other four species have white flowers. Knight's species, from Florida, *I. Knightii*, is particularly handsome, and blooms early in spring.

ISNARDIA. A genus of weedy plants, of the fuschia and clarkia order. The marsh species, *I. palustris*, is a small, creeping, floating, herbaceous evergreen of the ponds, pools, and other stagnant waters of Britain. Its roots are numerous, long, and thready; its stems are several, leafy, nearly simple, obscurely quadrangular, and 5 or 6 inches long; its leaves are opposite, ovate, acute, entire, bright green, somewhat succulent, and nearly an inch long; and its flowers are axillary, solitary, sessile, small, green, and inconspicuous, and bloom in July.

ISOCHILUS. A genus of beautiful, epiphytous, tropical plants, of the orchis family. Two very handsome species, *I. linearis*, with red flowers, and about 10 inches high, and *I. prolifer*, with white flowers, and about 6 inches high, were introduced to Britain from the West Indies before the close of last century; and several other species are known. The name isochilus signifies "equal lip," and alludes to the form of the flowers.

ISOETES. See Quillwort.

ISOLEPIS. A genus of sedgy plants, of the cyperaceous order. The floating species, *I. fluitans*—regarded by some botanists as a club-rush, under the name of *Scirpus fluitans*—is a curious-looking, perennial-rooted, floating indigen, of the ditches of Britain. The bristle-like species, *I. setacea*, is a small, odd-looking, annual indigen of the bogs of Britain, only 3 or 4 inches high, and flowering in July and August. The whole-schœnus species, *I. holoschœnus*, is a curious, perennial-rooted indigen of the sea-shores of some parts of England, growing 3 or 4 feet high, and flowering in July. Many exotic species are known; and a few of them have been brought to Britain as curiosities. The name isolepis signifies "equal-scaled," and alludes to the form of the flowers.

ISOMERISM. Identity in constituent elements, and in the proportions of these elements, in two or more substances which differ from each other in chemical properties. This fact is one of the most remarkable and interesting discoveries of modern science; it has already been detected in a considerable number of substances; and it seems to be leading the way to great and beautiful simplification in chemical theory. Two isomeric bodies are strictly identical with each other in the number of the atoms of each of their elements; and differ only in the aggregations of atoms in which the elements are combined.

ISOMORPHISM. Identity of form in two crystalline substances which differ from each other in chemical constitution. The arseniate salts, for example, have exactly the same form as the phosphate salts, — the binarseniate of soda the same as the biphosphate of soda, the binarseniate of ammonia the same as the biphosphate of ammonia, and each other arseniate the same as the corresponding phosphate,—the same, not only in crystalline shape, but also in the number of equivalents of acid, and water of crystallization, — and differing solely in the acid-radical of the one being arsenic and the acid-radical of the other being phosphorus. A number of other remarkable groups, strictly isomorphic, are well known to chemists.

ISOPLEXIS. A genus of ornamental, greenhouse shrubs, of the figwort order. It consists of two species, which were regarded by Linnæus and his immediate successors as foxgloves; and it takes its name of isoplexis, signifying "equal segment," from the relative size of the segments of the corolla.

The Canary species, *I. canariensis*—formerly *Digitalis canariensis*, or popularly shrubby Canary foxglove—is an evergreen shrub of about 4 feet in height, and was introduced to Britain toward the close of the 17th century. Its general appearance is similar to that of bear's-breech. Its stem is branched and shrubby; its leaves are alternate, spear-shaped, and nearly five inches long; and its flowers grow in loose spikes at the ends of the branches, and have a golden or bright orange colour, and bloom in succession from May till winter. This plant is propagated from seeds, and loves a soil of peaty loam, and does well in the open air in summer, but requires greenhouse protection throughout the winter.

ISOPOGON. A genus of ornamental, evergreen, Australian shrubs, of the protea family. About 14 or 15 species were introduced to Britain during the forty years succeeding 1790; and all these share the beauty and elegance for which their family are distinguished; all have a height of between 2 and 6 feet; most carry flowers of a pale colour; and nearly all require to be propagated from seeds, and thrive best in a soil of sandy mould.

ISOPYRUM. A small genus of ornamental, herbaceous plants, of the ranunculus order. The name signifies "equal to wheat," and alludes to the taste of the seeds. The fumitory-like species, *I. fumarioides*, is an annual, and a native of Siberia, and was introduced upwards of a century ago to Britain. The stem is from 3 to 12 inches high, and naked to the top, where there is a circle of leaves just under the flowers; the leaves are small and grey, and shaped like those of fumitory; and the flowers are small, greenish without, yellow within, and have five acute petals and as many honey-glands, and usually bloom in May and June.

ISORA. See Screw-tree.

ISOTOMA. See Lobelia.

ISSUE. The plaintiff and defendant, in a suit at law, are said to be *at issue*, when something is affirmed by one of them, which is denied by the other. The subject of this affirmation and denial may be either matter of fact or matter of law. If the defendent intends to dispute the truth of the statement whereon the plaintiff grounds his complaint, he denies either the whole of the statement, or some one material fact contained in it, which, in technical language, is called *traversing*. He then appeals to the decision of a jury, which is called *putting himself upon the country*. Although the plaintiff's statement be true, it does not necessarily follow that it discloses sufficient grounds for complaint against the defendant. If it does not so, the defendant admits the truth of the facts, but denies their sufficiency in law to support the action. In this case, he appeals to the decision of the judges; for the jury merely decide questions which involve matters of fact. Questions of mere law fall beneath the cognizance of the judges. When either the plaintiff or the defendant admits the facts, but denies the law of the other, he is said to *demur*. Although the plaintiff's statement, so far as it goes, be both true in point of fact, and sufficient in point of law, the defendant may still have a good defence; for the plaintiff may have stated the truth, but not the whole truth. Some facts may be suppressed, which, when explained by the defendant, may turn the scale in his favour. If this counter-statement of the defendant is insufficient in point of law as a defence, the plaintiff demurs; but if it is sufficient in point of law, he must either deny the facts, or allege some other facts to counterbalance them. By these means, the parties in the cause must ultimately arrive at some point, either of law or fact, at which they are at issue, and judgment will be given for that party in whose favour the issue is decided. The statements and counter-statements of the parties are called the *pleadings*, and each particular stage in the pleadings has a name appropriated to itself. These names are, 1. the *declaration;* 2. the *plea;* 3. the *replication;* 4. the *rejoinder;* 5. the *surrejoinder;* 6. the *rebutter;* and 7. the *surrebutter*. The first, third, fifth and seventh names belong to the pleadings of the plaintiff; the second, fourth and sixth to the defendant. Issue is generally taken before the parties arrive at a surrebutter. In former times, the pleadings were conducted *viva voce*, in open court, and the judges presided, like moderators, during the dispute, until the parties arrived at an issue; but they are now drawn up in writing out of court, and are then filed by the attorneys in the proper offices attached to the court. The judges now hear nothing of them until the issue of fact comes on for trial, or the issue at law for argument. If the existence of a particular record is put in issue, it must be produced by the party who affirms its existence; and the court, at the time appointed for its production, decides the issue without the intervention of a jury. This is one of the very rare cases where the jury are not the sole judges on questions of fact. There is a rule of pleading, that only one material fact shall be put in issue in one plea. To this rule the *general issue* forms a wide exception. When a special plea is pleaded, evidence is only admissible as to the truth or falsehood of the particular fact which is the subject of that plea; but the general issue is a species of plea which usually compels the plaintiff to prove his whole case to the satisfaction of a jury, and, at the same time, enables the defendant to prove any circumstances whatever which discharge his liability. Thus, if an action be brought against a man for the price of goods which the plaintiff alleges that the defendant bought, if the defendant has become a bankrupt since the purchase, he may plead that fact specially, and then the evidence is confined to the single question—Has he or has he not become bankrupt? But if he pleads the general issue, then he may prove either that he never bought the goods, or that he paid for them, or that he returned them to the plaintiff on finding them to be of an inferior quality, or, in short, any thing else which is a bar to the action. The form of the general issue, in this case, is simply "that the defendant did not promise or undertake in manner and form as the plaintiff has complained against him." Owing to this latitude allowed to the general issue, it sometimes happens that plaintiffs are taking by surprise at the trial, by the defendant setting up an unexpected defence, which the plaintiff, on the spur of the moment, is unable to disprove. When this is proved to the satisfaction of the judges, they will, if the justice of the case require it, grant a new trial.

ITALIAN-BEECH, or Italian Oak. See Oak.

ITALIAN RYEGRASS. See Ryegrass.

ITCH. A cutaneous disease in sheep and horses, analogous to itch in man. But it is commonly called scab in the case of sheep, and mange in the case of horses. See the articles Scab and Mange.

ITEA. A hardy, deciduous, ornamental shrub, of the heath family. It constitutes a genus of itself; and is specifically called the Virginian. It was introduced to Britain about a century ago from North America. Its stem is 6 or 7 feet high, and well branched on all sides; its leaves are alternate, spear-shaped, slightly serrated, and light green; and its flowers are white, and grow in erect spikes of 3 or 4 inches in length, and come out in such profusion as almost to cover the shrub, and bloom and make a fine appearance from June till August. This plant is propagated by layering, and loves a moist sandy mould soil, and becomes sickly or dies on dry gravelly ground.

IVA. A genus of exotic plants, of the ambrosia division of the composite order. Several species have been introduced to Britain from America; and one of these, *I. frutescens*, is a somewhat ornamental, white-flowered, autumn-blooming, hardy, deciduous shrub, of 4 or 5 feet in height. Iva is also the name of an odd-looking, annual-rooted, yellow-flowered, hardy plant, of the bugle genus.

IVY,—botanically *Hedera*. A genus of ornamental, ligneous plants, of the aralia family. The common ivy, *Hedera helix*, is a well-known evergreen creeper and climber, found throughout almost the whole of Europe, and in many parts of Asia and Africa. It easily attains a height of from 30 to 45 feet. The leaves are smooth and shining, varying much in form, from oval to three or five lobed. The commony ivy is propagated by its trailing branches, which put out roots along their whole length, and which being cut off and planted, readily take root in almost any soil or situation. It may also be propagated by seeds, which should be sown soon after they are ripe. That species of ivy, with oval five-lobed, sawed leaves, called the Virginia Creeper, is propagated by cuttings, which if planted in autumn, on a shady border, will be fit for transplanting in the following autumn.—The paper of inquiries to churchwardens, issued by the archdeacon, sometimes contains the question, "Is there any ivy growing on the walls, &c.?" A rural dean contends that, so far from the ivy rendering the structure damp and so hastening its decay, nothing so effectually keeps the building dry, as may be seen by examining beneath the ivy after rain, when it will be found that the walls are dry, though everything around is deluged with wet. And further, he contends that "its exuberant and web-like roots, issuing, as they do, from every portion of the branches, and running all over the surface on which it grows, bind everything together that comes within their reach with such a firm and intricate lace-work, that not a single stone can be removed from its position without first tearing away its protecting safeguard." In proof of this, he refers to ruins of our ancient castles and abbeys; "for while in those parts of the structure that have not had the advantage of this protection all has gone to utter decay, where the ivy has thrown its preserving mantle everything is comparatively perfect and fresh, and oftentimes the very angles of the sculptured stone are found to be almost as sharp and entire as when first they came from the mason's yard."—Five varieties of the common ivy are in cultivation; two species of ivy have been introduced to Britain from the Canary Islands and the West Indies; and several other species are known.

IXIA. A genus of very beautiful, bulbous-rooted, Cape-of-Good-Hope plants, of the iris order. A considerable number of species formerly included in it, are now assigned to the genera sparaxis, trichonema, hesperantha, babiana, and synnotia; but nearly 30 introduced species, besides many varieties and hybrids, are still ranked as true ixias. The species very greatly and gorgeously vary in the colours and tints of their flowers; and they vary from about 6 to about 24 inches in the height of their flower-stem, and from the middle of winter till the early part of autumn in their period of blooming; but they have a close common resemblance in their foliage, their general appearance, and their physiological habits. They are very differently treated by different florists, and, in consequence of frequently failing, are thought by many to require much skill and nicety of management; but if they get proper soil, due repose, and early enough planting, they will grow as readily and bloom as vigorously as almost any other bulbous-rooted plants except the very hardiest. They require a peaty soil, or a compost of decayed leaves and sandy loam; they ought to be allowed to sink into profound repose the instant they have done flowering; those which are potted should not receive any water till they rise out of their repose, and should be kept only in such a cool frame as shall protect them from frost; and, though most will grow well on a south border in the open ground, they require to be committed to the ground before they give any decided indication of having commenced their vernal growth.

As much confusion and many discrepancies prevail in the nomenclature of the ixias, we shall select and briefly notice the choicest species. The green-flowered ixia, *I. viridiflora*, was introduced in 1780, and has long been well known. Its stem is about a foot high; and its flowers have a bright green colour, with a black centre, and bloom in May and June.—The crater-like ixia, *I. crateroides*, was introduced a year or two before the preceding, and is much admired for its splendour. Its stem is 6 or 7 inches high; and its flowers are large and campanulate, and have a bright rich crimson colour, and bloom in the early part of summer.—The courtly ixia, *I. aulica*, was introduced even earlier than the two preceding. Its bulb is small; its stem is tender, flexible, and nearly two feet high; and its flowers have various shades of pink, and bloom in April and May.—The stained ixia, *I. fucata*—sometimes called also *I. striata* and *I. pallida*—was introduced in 1800, and is very common. Its bulb is small and flat; its stem is 6 or 7 inches high; and its flowers are white, with minute pink stripes, and bloom in June and July.—The squill-flowered ixia, *I. scillaris*, was introduced about 60 years ago, and is much more tender than most of the other species. Its bulb is very small; its stem has a branching habit, and seldom exceeds 6 or 8 inches in height; and its flowers are small and star-like, and have a white colour tipped with pink, and bloom in January and February.—The spreading-flowered ixia, *I. patens*, was introduced about 68 years ago, and is hardy, handsome, and well-known. Its stem is 9 or 10 inches high; and its flowers are crimson-coloured, and bloom in April.—The curled-leaved ixia, *I. crispa*, has a middle-sized stem, and a small pink flower, and is tender and scarce, and is easily known by its curly or fringed foliage.—The awned ixia, *I. aristata*, has a dwarfish stem, and a pale-veined, pink, bell-shaped flower, and is very distinct from most of the other species.—The drooping ixia, *I. pendula*, has a very tall and remarkably slender stem, lilac or bluish flowers, and root and foliage similar to those of a small iris, and is a very distinct species.—The lilac ixia, *I. lilacea*, comprises at least eight permanent varieties, most of middle-sized stem, all with some shade of lilac or light purple flowers, and some occasionally regarded as separate species.—The headed ixia, *I. capitata*, also comprises a number of permanent and quite distinct varieties; and one of these, *I. capitata tricolor*, is a very beautiful, very distinct and very early variety, with small white bulbs, and with flowers whose centre is black, whose main part is white, and whose margin is an orange halo. The white-flowered ixia, *I. leucantha*, is rather tender, and has a dwarfish stem, and a somewhat large, purely white, and perfectly spotless flower.—The short ixia, *I. curta*, has a dwarfish stem, and a large, campanulate, orange-coloured flower, with a pale brown centre, and is very scarce and a shy bloomer.—The conical ixia, *I. conica*, has a small brown bulb, a dwarfish stem, and a bright orange flower, with a black centre, and is rather tender but decidedly handsome.—The long-flowered ixia, *I. longiflora*, is hardy and common, with a dwarfish stem; and one variety of it has a buff flower, while another has a rosy-coloured flower, with dark shading in the centre.

IXORA. A genus of ornamental, tropical, evergreen shrubs, of the madder order. Several species formerly included in it are now assigned to other genera; but at least a score of species in British hothouses still belong to it; and ten or a dozen more are known. All are fine-looking shrubs, and rank in the very first class of ligneous plants for magnificence of bloom. They vary in height from 2 to 25 feet; but most have a height of from 3 to 6. The largest group of the introduced species have white flowers; and the next largest have flowers of a scarlet colour, or of some other shade of red. All require repose from August till February, and may then be kept in a greenhouse; and all may, in February, be re-potted, and plunged in a mild moist heat of from 60° to 70°; and if thus treated, they will bloom in April or May, while, if treated in any ordinary safe method, they will not bloom till July or August. All are propagated from cuttings, and love a well-drained, sandy, open soil, composed of peaty mould and arenaceous loam.

The fragrant ixora, *I. odorata*, is a recently introduced species, equal in beauty to most of the better known species, and possessing the additional recommendation of a most delicious fragrance in its flowers. The leaves are opposite; broadly ovate, from 6 to 9 inches long, and almost vieing in firmness of texture with those of the Indian caoutchouc, *Ficus elastica;* the lower leaves are stalked, and the upper ones quite or very nearly sessile; the floral panicles are large, branching, spreading, and sometimes a foot or more in diameter; the ultimate ramifications of the panicles produce each three flowers; and each flower is from 4 to 5 inches long, and consists of a very long slender tube, and four expanding, spreading, ovate segments,—the tube red below and white above, and the segments at first white and afterwards buff and twisted.

The flowers of some one or more species are offered in Hindoo superstition to a Malabar idol, from whom the whole genus takes the name of ixora; and the flowers of the great-flowered species, *I. grandiflora*, an orange-flowered plant of 4 or 5 feet in height, introduced to Britain in 1814, —and those of the Bandhooka species, *I. Bandhuca*, a carmine-flowered plant of 3 or 4 feet in height, introduced in 1815,—are commonly offered on the shrines of Sheeva and Vishnoo.—The small-flowered species, *I. parviflora*, seemingly not yet introduced to Britain, and popularly called torchwood by the Indo-Britons, is a small tree, of considerable economical value in India, its stems being made into beams and posts in house-building, and its branches serving as flambeaux to nocturnal travellers, and affording both a clear and a very ready light.

J

JABOROSA. A recently discovered genus of ornamental, herbaceous plants, of the nightshade family. The runcinate species, *J. runcinata*, introduced to Britain from South America about 16 years ago, was supposed to resemble the mandrake, and therefore assumed the Arabic name of that plant, Jaborosa. It is a very beautiful herbaceous evergreen, of 6 or 8 inches in height; and requires greenhouse culture.

JACARANDA. A genus of ornamental, tropical, evergreen, ligneous plants, of the bignonia family. The Bahama species, *Jacaranda bahamensis*, called by Linnæus *Bignonia cærulea*, and sometimes popularly called bastard guaicum, is a native of the Bahama Islands, and was introduced to Britain in 1724. Its stem grows naturally to the height of about 20 feet, and sends out many lateral branches; its leaves are compoundly pinnate, and have each eleven alternate wings; its leaflets are small, spear-shaped, alternate, and entire; and its flowers grow in very loose panicles at the ends of the branches, and consist each of a long, swelling, blue tube, with a spreading top, cut into five unequal segments.—Six other species, all equal or superior to the preceding in natural height, the majority also with blue flowers, and all thriving best in a soil of mixed mould and loam, have been introduced to our hothouses.

JACA-TREE. See Bread-Fruit-Tree.

JACKDAW,—*Corvus monedula*, Lin.—A bird of the crow kind, celebrated for his copious vocabulary and garrulous habits. It is about thirteen inches in length, with black bill; white eyes; the hinder part of the head and neck of a hoary-grey colour; the rest of the plumage of a rich glossy black above, beneath dusky; the legs are black. The jackdaw is very common in England, where it remains the whole year; in France, and various other parts of the continent of Europe, it is migratory. It is gregarious, frequenting old towers and ruins, where it builds its nests. The female lays five or six eggs of a greenish colour, and is exceedingly assiduous in her attention to the young after they are hatched. These birds principally live on worms and the larvæ of insects, but they also appear to be capable of taking fish. Bingley states that he was witness to an instance where a jackdaw was very successful in this mode of obtaining food. It is easily tamed, and may be taught to pronounce many words with little difficulty. The jackdaws are notorious thieves, not only stealing food, but appearing to be particularly fond of shining substances, as money, &c., and have frequently occasioned suspicions of theft in persons who were afterwards proved innocent. So far do they carry this propensity, that they have been known to carry off spectacles from persons who were reading.

JACK-IN-A-BOX. See Hernandia.

JACK-SNIPE. See Snipe.

JACKSONIA. A genus of beautiful, evergreen, Australian shrubs, of the sophora division of the composite order. Four species, all yellow-flowered and less than 2½ feet high, and some of them bearing considerable resemblance to our common broom, were introduced to Britain during the first quarter of the present century; and other species were introduced at a later period.

JACOBÆA. Two species of groundsel,—*Senecio Jacobæa* and *Senecio elegans*. The former is the common, perennial-rooted, yellow-flowered ragweed, or ragwort, of the dry pastures of Britain. See the article Groundsel. The latter now figures in almost all the seed-lists of seedsmen under the name of *Jacobæa elegans*; and is one of the best known and most beautiful of our half-hardy annuals. Several very distinct varieties of it are in cultivation,—particularly the white-flowered, the red-flowered, the purple-flowered, the yellow-flowered, and the brown-flowered; and many of its double flowers are as full as those of a prime bachelor's-button, or a very double daisy, and possess great showiness and elegance. This plant often succeeds perfectly well when treated as an ordinary, late-sown, hardy annual.

JACOBÆA LILY, — botanically *Amaryllis Formosissima*. A beautiful, bulbous-rooted, liliaceous plant, introduced to Britain from Mexico about the middle of the 17th century, and extensively cultivated in this country as one of the most brilliant of the amaryllides. Its root, especially when kept in a moderate warmth during winter, sends off a profusion of offsets; its stems are produced successionally from the sides of the bulb, so that, when a flower on one side decays, a stem from the other side begins to rise; and its flowers are large, and of a very deep red colour, and nod on one side of the stem,—and, though rarely more than one grows on a single stem, yet they can be made to bloom in succession, upon a succession of stems, from March till the beginning of September. The bulbs should be potted in August, in medium-sized pots, filled with light kitchen-garden soil.

JACOB'S LADDER. The common blue-flowered Greek-Valerian. See Polemonium.

JACQUEMONTIA. A recently constituted genus of ornamental plants, of the bindweed order. About a dozen known species have been assigned to it, all natives of tropical America, with a peculiar habit, and rich blue or rarely white flowers. Its main botanical character is an intermediate form of stigma between the globose form which characterises the ipomœas, and the linear form which characterises the true convolvuli. The five-flowered species, *J. pentantha*, has long been an inmate of our stoves, and recommends itself to general favour by its lively-coloured, spring-blooming flowers.

JACQUINIA. A genus of ornamental, tropical, evergreen, ligneous plants, of the myrsine family. The long-fruited species, *J. macrocarpa*, is a beautiful, orange-flowered shrub of 8 or 10 feet in height, and was introduced to Britain about 22 years ago from Mexico. Its bark is reddish; its leaves are alternate or irregular, oblong or lanceolate, two or three inches long, very acutely pointed, and entire and thickened in the margin; its flowers grow in short racemes at the ends of the branches, and bloom from May till September; and its fruit is a kind of berry, about 9 or 10 lines in diameter, with a thick, coriaceous, almost ligneous, orange-coloured rind, and a few dark-brown seeds, lying upon a large fleshy placenta.—The bracelet species, *J. armillaris*, is a West-Indian white-flowered shrub, of about the same height as the preceding; and was introduced to Britain about 80 years ago; and takes its name from the circumstance of its shining brown and yellow seeds being strung together and worn as bracelets by the inhabitants of the French Islands.—Four or five other species, varying in height from one foot to 15 feet, have been introduced; and several more are known.

JAELA. See Goat.

JALAP. A purgative exotic root, well known in commerce, and sold, in the state of powder, in probably every drug-shop in Britain. But the plant which yields it has been the subject of much delusion and many disputes among botanists. This plant is a native of the vicinity of the city Xalappa in Mexico; and is said by some authorities to have been cultivated in some hothouses in England in the 7th decad of the 17th century, and by others to have been introduced to Britain only so late as about 1733. But the true plant was eventually lost in all our gardens; and several other plants were long mistaken for it, and cultivated under its name, till the species and even the very genus of the true plant became uncertain or unknown. Several original researches within the last 20 years, however, have fully ascertained the plant to be an ipomœa of a different species from any which had recently been cultivated in Britain under its name, and have concurred in calling it *Ipomœa Jalapa*. This plant grows in a dry sandy soil, and does not possess anything like the degree of tenderness which the old botanists ascribed to it. Its roots are perennial tubers, irregularly egg-shaped, externally dark brown, and internally white; its stems are numerous, twining, cylindrical, and from 10 to upwards of 20 feet in height; its leaves are smooth, bright green, and variously shaped; and its flowers grow on compound axillary footstalks, and are large, funnel-shaped, and either red, pink, or lilac, and bloom in August and September.

The dried jalap root of commerce is hard, compact, and heavy, and has a resinous fracture, a lusciously heavy odour, and a nauseously sweetish and somewhat pungent taste. The powder of it has a pale brownish-yellow colour; and, when fresh and unadulterated, strongly emits the peculiar odour of the root. Jalap surrenders part of its active properties to water, part to rectified alcohol, and the whole to diluted alcohol. The powder of it is a stimulating cathartic and powerful hydragogic purgative; the watery extract is a moderate purgative; and the alcoholic extract is but slightly aperient and yet violently griping. Almost all old writers on farriery recommended jalap as an ingredient in purgative balls; and most of the practical farriers of the last generation put two or three drachms of it into every dose of physic for a horse; but all well-informed veterinarians during the last forty years know it to be very mischievous to horses, scarcely purging them at all, but creating great sickness and some disease, and have in consequence completely discarded it from their list of medicines.

JAMAICA DOGWOOD,—botanically *Piscidia Erythrina*. An evergreen, West Indian, timber tree, of the lotus division of the leguminous order. It has a natural height of about 30 feet, and was long ago introduced to curious British hothouse collections.

JAMAICA EBONY,—botanically *Brya Ebenus*. An ornamental, tropical, large, evergreen shrub, of the dalbergia division of the leguminous order. It has a natural height of about 15 feet, and carries somewhat herbaceous-coloured flowers in July and August.

JAMAICA PEPPER. See Allspice-Tree.

JAMAICA REDWOOD,—botanically *Gordonia Hæmatoxylon*. An evergreen, West-Indian, timber tree, of the ternstrœmia family. It carries white flowers, and has a natural height of between 40 and 50 feet.

JAMAICA ROSE,—botanically *Meriana*. A small genus of beautiful, evergreen, West-Indian shrubs, of the melastoma order. Three species, the white-flowered, the scarlet-flowered, and the purple-flowered, all about 6 or 7 feet high, and remarkable for the showiness and brilliance of their large flowers, have been introduced to the hothouses of Britain.

JAMES' POWDER. See Antimony.

JAMOCK, or Jannock. A thick, soft, doughy kind of oaten bread. The name is provincial.

JANIPHA. A genus of tropical, evergreen, brown-flowered shrubs, of the euphorbia order. Five or six species, all about 3 or 4 feet high, have been introduced from tropical America to the botanical collections of Britain; three of these are cultivated for economical purposes in their native country; and two of these three are highly valued for their farinaceous tubers. See the article CASSAVA.

JANUARY. See CALENDAR.

JAPAN LILY. See LILY.

JARGONELLE. See PEAR.

JASIONE. See SHEEP'S SCABIOUS.

JASMINE, or JESSAMINE,—botanically *Jasminum.* A genus of ornamental, ligneous plants, constituting, with the genus nyctanthes, the natural order Jasmineæ or Jasminaceæ. This order is nearly allied to the far larger one which has the olive-tree for its type, being identical with it in medicinal properties and in most botanical characters, and differing principally in producing its ovules erectly while the olive-tree order produces them pendulously. As only one plant, the tree of sadness, is a nyctanthes, the order and the genus of the jasmine are nearly coextensive. About 40 species occur in the gardens of Britain; and about a dozen more are known.

The common white jasmine, *Jasminum officinale,* is one of the best known and most highly esteemed of our hardy ligneous climbers; and has long been an universal favourite with poets and ladies for the sweetness of its fragrance; and maintains a similar place in the shrubbery to that which mignionette holds in the flower-border of the annuals,—the most prized of all for perfume, but by no means remarkable for beauty. It is a native of India, and was introduced to Britain about the middle of the 16th century. Its stem is feeble, and requires support, and can easily be coaxed up to the height of from 12 to 20 feet; its branches are numerous, slender, weak, pithy, and clothed with a brown, dirty-looking bark; its young shoots are abundant and prolific, and have a smooth and delightfully green bark, and exhibit both the foliage and the bloom; its leaves are opposite, pinnated, dark green, and very beautiful; its leaflets are pointed and usually amount to three pairs and a terminating odd one,—the latter larger than any of the others, and with a longer or more protracted point; and its flowers are delicately-shaped, and have a white colour, and bloom from June till October. "Jasmines," says Phillips, "should be woven into the trellised arch or alcove, climb the palisades, rest on the branches of the broad-leaved laurel, cover the dead wall, and run gaily wild over the shrubs of the wilderness walks, whilst, obedient to the scissors of the gardener, they are formed into bushy shrubs and little trees for the near approach to the dwelling, where, in the morning and evening, their star-topped tubes send forth a shower of odours that embalm, refresh, and purify the surrounding air.

'—— Many a perfume breathed
From plants that wake when others sleep;
From timid jasmine buds, that keep
Their odour to themselves all day,
But when the sunlight dies away,
Let the delicious secret out
To every breeze that roams about.'"

But this advice contains far more poetry than horticulture; and ought to be modified by such remarks as the following judicious ones of Marshall:—"The branches of the jasmine afford shelter for snails, spiders, and other insects; which in winter, when the leaves are fallen, will give them an unsightly look; and if they are clipped and kept up to the wall, as the flowers are produced from the ends and wings of the shoots, these must of course be sheared off; so that little bloom will be found, except what is at the top of the tree. It is not, however, to dissuade those people who are fond of it from planting it against walls. It naturally requires support, though attended with these defects. It may, nevertheless, be planted amongst shrubs in the shrubbery, to appear to great advantage. It should keep company with the lower kinds of shrubs; and whenever the branches grow too high to sustain themselves without nodding, and discover their rusty stems, these should be taken off from the bottom." It loves a light warm soil, but will thrive in any ordinary garden ground in a sheltered situation. Four permanent varieties of it are in cultivation,—the common white, the silver-leaved, the golden-leaved, and the double-flowered; and all may be readily propagated from cuttings planted under a glass, or from layers in the open ground.

The low or Italian or yellow-flowered jasmine, *Jasminum humile,* is a hardy, deciduous shrub of the south of Europe, and was introduced to Britain in the 6th decad of the 17th century. It can support itself in an erect position, and maintain its branches from trailing on the ground; and is well adapted to occupy a place in the shrubbery. Its stem is 3 or 4 feet high; its branches are fewer and stronger than those of the common white jasmine, and have an angular outline, and a smooth, deep-green bark; its leaves are alternate, and partly pinnate but chiefly trifoliate; its leaflets are smooth, and much broader than those of the white jasmine, and continue to so late a period in winter as to render the plant a sub-evergreen; and its flowers are yellow and comparatively large, and bloom from June till September. This plant is very hardy; and may be propagated from either layers or cuttings.

The sprouty or common yellow jasmine, *Jasminum fruticans,* is also a hardy, deciduous shrub, of the south of Europe; and was introduced to Britain in the latter part of the 16th century. It has a medium habit between the climbing one of the common white jasmine, and the erect one of the Italian jasmine; and may either be planted in the shrubbery, or placed against a wall or trellis. Its stem may be drawn up to the height of 10 or 12 feet; its branches are weak and slender; its young shoots are angular and somewhat hairy, and have a fine strong green colour; its leaves are alternate, sometimes single but generally trifoliate, smooth, thickish, and of a fine deep green colour, and remain so long on the branches as to render the plant a sub-evergreen; and its flowers are yellow, and do not possess any of the fragrance of the preceding species, and soon bloom out, yet maintain a sort of succession from spring to the latter part of autumn.

The narrow-leaved jasmine, *J. angustifolium*, grows wild in the woods of India, and was introduced about 30 years ago to the hothouses of Britain. It is an evergreen climber, of 10 or 12 feet in height. Its flowers are white and beautiful, and bloom throughout the year, and are highly prized by the inhabitants of India. Its root has a bitter taste; and when reduced to powder, and mixed with *Acorus calamus*, and lime juice, is regarded by the Hindoos as a valuable external application for ringworm and herpes.—The Sambac jasmine, *J. Sambac*, is an evergreen, East Indian, white-flowered climber, of 6 or 8 feet in height, and was introduced to Britain in the latter part of the 17th century. Two varieties of it, introduced at a somewhat later period, are respectively three-leaved and double-flowered; and these, as well as the normal plant, bloom throughout the greater part of the year.—About one-half of the other introduced species are suitable for the greenhouse, and all the rest, like the narrow-leaved and the Sambac, require the stove; and while all are evergreen, not more than 10 or 11 can maintain their branches without support. They grow and flourish well in a mixture of peat, sand, and loam; and are easily propagated from cuttings under a glass in the proper degree of heat.—The fragrance for which many of the jasmines are celebrated is due to an essential oil, which can be separated by distillation, and is one of the best-loved and most delicate of our perfumes; and the oil of jasmine of commerce is obtained chiefly from *J. officinale*, *J. Sambac*, *J. grandiflorum*, and perhaps *J. auriculatum*, and *J. undulatum*.

JATROPHA. A genus of tropical plants, of the spurge family. Two of the most remarkable species formerly included in it, now belong to another genus. See the articles JANIPHA and CASSAVA. Upwards of 20 known species are still included in it; and upwards of a dozen of these have been introduced to the hothouses of Britain. Nearly all the introduced species have an evergreen shrubby habit, and a somewhat ornamental appearance; and several are very strongly characterised by the poisonously acrid properties which more or less distinguish the majority of the euphorbiaceæ. The fruit of two of them, in particular, is tremendously and dangerously purgative, and has occasioned the whole genus to be sometimes called the physic-nut, but is far too active and perilous to be allowed a place in the materia medica of our colleges.

One of the best known species, *J. multifida*, introduced to Britain toward the close of the 17th century, and popularly called the French physic-nut, is described as follows by Miller, and may be regarded as an eminently ornamental specimen of the whole genus. "This rises with a soft thick stem 8 or 10 feet high, dividing into several branches, covered with a greyish bark. The leaves come out on every side the branches, on strong footstalks, 7 or 8 inches long: they are divided into 9 or 10 lobes in form of a hand, joined at their base; these are 7 inches long, and about 2 broad, with many jagged points on their borders standing opposite. The upper sides of the leaves are of a lucid green, but their under side is gray, and a little cottony. The flowers come out upon long footstalks from the end of branches, formed into an umbel, in which are the male and female flowers, as in the other species; these umbels are large, and the flowers, being of a bright scarlet, make a fine appearance, and the leaves being very remarkable for their beauty, has occasioned the plant being cultivated for ornament in most of the islands of the West Indies."

The angular-leaved species, *J. curcas*, occurs in both India and South America, and was introduced from the latter country to Britain in the fourth decad of last century. It grows 4 or 5 feet high, and has a shrubby habit, five-angled leaves, and greenish-coloured flowers. Its seeds are sometimes used in India as a purgative; its leaves are used as a discutient; its milky juice is supposed to possess detergent and healing properties; and a fixed oil, obtained from its seeds, is used for burning in lamps, and as a valuable external application for itch, herpes, and chronic rheumatism.—One of the unintroduced species, *Jatropha elastica*, a native of South America, yields large quantities of caoutchouc.

JAUNDICE. A bilious disease in man and in some of the lower animals. It attacks the horse, the ox, and the sheep; and, in the nomenclature of the farmery, is very generally called the yellows.

Jaundice in the horse, does not arise from an obstruction in the biliary ducts or tubes, as in the human subject,—for the horse has no gall-bladder, and only one biliary duct; but it arises sometimes from mere sympathy of the liver with inflammation in the bowels or the lungs, and sometimes from such idiopathic accelerated action in the liver as causes bile to be secreted in excess, and to be sent into the general circulation.—Its usual symptoms are yellowness of the eyes and mouth, dulness, lassitude, impaired appetite, reddish or dark-coloured urine, lameness of the right foreleg, and sometimes costiveness. but more commonly purging. Inflammation of the liver is sometimes mistaken for it, but may be readily distinguished by its accompanying fever and debility.—When jaundice is merely symptomatic, it disappears after the suppression of the disease which excites it; but when it is idiopathic, it must be treated promptly, discerningly, and in adaptation to its peculiarities of virulence or character. When inflammatory action is indicated, the horse must be bled proportionately to the apparent degree of the inflammation, and to his occasional stupor; but when little or no inflammatory action seems to exist, the healthful tone of the liver may be restored by means simply of regulating the bowels, giving select food, strengthening the stomach, and keeping up genial warmth and thorough ventilation. Costiveness must be subdued by moderately purging balls, and excessive or undue relaxation of the bowels by the medicines suitable for diarrhœa; thin gruel, infusion of malt, and carrots and green fodder should be the only food; a few slight tonics should be given after the disease begins to give way; and the horse should, all along, be warmly clothed, and the stable kept well ventilated, but not cold.

Jaundice in cattle is both a more diversified and a more dangerous disease than jaundice in horses. It arises from very many and exceedingly different causes,—among others, inflammation of the liver, inflammation of the biliary ducts, inflammation of the duodenum, sudden change of weather, the presence of the fluke-worm, and the formation of biliary calculi. It is particularly prone to attack cows in spring and in autumn. It sometimes establishes itself so slowly and insidiously as almost to defy detection till it has obtained a perilous hold on the constitution; and at other times, it appears suddenly and violently, and challenges the attention of even the most unobserving cattle-man. Its pervading symptoms are languor, impaired appetite, loss of condition, and yellowness of eyes, skin, urine, and sometimes the very hair and milk; and its concomitant symptoms, in cases of rapid and violent development, are fever, heaving of the flanks, excessive thirst, and general irritation.—The proper treatment is, as to general principles, the same as that for jaundice in the horse, and must so vary in different cases as to accord with the peculiar symptoms. Some writers allege that it can be easily cured; but the more judicious and experienced pronounce it so insidious as often to go beyond the reach of remedy before it can be detected, and so intractable, in even its more patent forms, as sometimes to defy the power of medicine. "The following short directions," says the Useful Knowledge Society's Treatise on Cattle, "comprise all that can be done:—subdue the inflammation or fever by bleeding and physic;—keep the bowels afterwards under the mild but evident influence of purgative medicine;—add aromatics and stomachics to the medicine almost from the beginning; to these, if the strength and condition of the animal should appear to be wasting, add tonics—the gentian root will stand at the head of them; and lastly, when the disease has been apparently subdued, a few tonic drinks will restore the appetite, prepare for the regaining of condition, and re-establish the secretion of milk."

Jaundice in sheep is a rather rare disease; and though sometimes destructive, is by no means so dangerous as some other maladies of the hepatic system. Both the symptoms and the cure are nearly the same as in cattle. Sir George Mackenzie says, "Bleeding is useful; and a dose of jalap, with perhaps a few grains of calomel, will be of service; exercise is very efficacious."

JAY,—scientifically *Garrulus Glandarius.* A British bird, of the crow division, and conirostrous family of the passerinæ. It abounds in some of the wooded districts of England, occurs in some of the southern and midland parts of Ireland, and is common throughout many wooded portions of Continental Europe. Its total length is nearly 14 inches; its general form is handsome; its forehead, crown, and other parts are vinous grey; its elongated feathers form a crest which it can elevate at pleasure; its mustache, on each side of the lower mandible, is an inch in length, and velvety black, and forms a remarkable feature; its wing-coverts have a large spot of dazzling blue, striped with a deep shade of the same colour, and forming another remarkable feature; its breast and belly are reddish buff; its tail-quills are black; and its legs, toes, and claws are pale brown. It lives in pairs or in small flocks, and builds in a thick bush or tall hedge. Its nest is shaped like a cup, and well lined with grasses and fine fibrous roots. Its eggs have a yellowish-white ground colour, and a light brown and profuse variegation. This bird mimics the cries of other birds, and of domestic animals; it feeds principally on acorns; and it has been generally supposed to injure young trees.

JEFFERSONIA. A small, handsome, hardy, white-flowered, May-blooming, perennial-rooted, North-American, herbaceous plant, of the poppy family. It constitutes a genus of itself, and is specifically called the two-leaved; and it was ranked by the old botanists as a duck's-foot, under the name of *Podophyllum diphyllum.*

JERSEY-PINE. See PINE.

JERSEY STAR-THISTLE. See CENTAUREA.

JERUSALEM ARTICHOKE. See ARTICHOKE.

JERUSALEM SAGE. See PHLOMIS.

JESSAMINE. Se JASMINE.

JOB'S TEARS,—botanically *Coix.* A genus of exotic grasses, of the maize tribe. Three species have been introduced to the botanical collections of Britain from India, and two from respectively China and Mexico; and all are perennial-rooted, and have a curious appearance, and are usually from 2 to 4 feet high. The common species, *Coix lachryma,* was brought from India toward the close of the 16th century. Its culm, in favourable circumstances, attains a height of about 8 feet; and it branches out, becomes hard like reeds or the culm of maize, and produces several spikes of flowers. This plant, when sown in the bark stove, ripens its seeds in the second year.

JOHN'S-WORT (St.). See Hypericum.

JOINT, in general, denotes the juncture of two or more things. The joints of the human body are called, by anatomists, *articulations*. The suppleness to which the joints may be brought, by long practice from the time of infancy, is very surprising. Every common posture-master shows us a great deal of this; but one of the most wonderful instances of it was in a person of the name of Clark, and famous for it in London, where he was commonly known by the name of Clark 'the posture-master.' This man had found the way, by long practice, to distort many of the bones, of which nobody before had ever thought it possible to alter the position. He had such an absolute command of his muscles and joints, that he could almost disjoint his whole body; so that he once imposed on the famous Mullens, by his distortions, in such a manner that he refused to undertake his cure; but, to the amazement of the physician, no sooner had he given over his patient, than he saw him restore himself to the figure and condition of a proper man, with no distortion about him.

JOINT-FELLON. See Rheumatism.

JOINT-STOCK COMPANIES. Where any branch of business requires a greater capital to prosecute it with advantage than can ordinarily be furnished by an individual, or by a number of individuals actually engaged in conducting it, or where the business is attended with great risks, and may, as events turn out, be very profitable, or result in great losses, as in the case of insurance, it is desirable that the laws should give facility to the combination of the contributions of numerous persons, in great or small amounts, to make up the requisite capital.

The first and most obvious combination for purposes of business, is that of co-partnerships, whereby each of the members renders himself answerable, *in solido*, or absolutely, and to the full extent, on all contracts made by the company. This is a sort of association, existing in all places; but if the business to be conducted be of the descriptions above mentioned, the copartnership is not a convenient mode of association, since the capital contributed by many must necessarily be managed by a few; and therefore, if each member is liable, *in solido*, on the contracts of the company, the fortune of each is put in jeopardy, by ever so small a contribution to the joint-stock. This must operate, of course, to discourage useful undertakings on a large scale, and even if it did not, it might still be very important to provide for associations, with a limited liability of the individual members, since the ruin of any individual will necessarily affect others to a greater or less extent. The shocks, and individual derangements and reverses, which are necessarily incident to enterprises of industry and trade, make it very desirable to secure, by some modes of association, an apportionment of risks, losses and gains among a great number. This is done by means of private corporations, joint-stock companies, and limited co-partnerships.

In regard to the two first descriptions of association, it is not always the purpose of their institution to limit the responsibility of the members. In the case of towns, for instance, and so in regard to some other local corporations, an execution, issuing on a judgment recovered against the corporation, may be levied upon the property of any member. So, in some instances, the individual members of banking or manufacturing corporations are liable absolutely, and without limit, for the debts of the company: but, in general, in both corporations and joint-stock companies, only the capital stock is liable for the contracts of the company. Each member pays in his amount of this stock, which he knows to be subject to the risks of the business to be pursued. He can estimate precisely, therefore, the extent, the utmost limit, of his hazard in the most unfavourable event. With this limitation, many will be ready to embark their capital in enterprises attended with the chances of great gain, or losses, according to the event, who would be quite unwilling to take the hazard of being individually liable for the whole amount of the losses of the whole concern, or of guaranteeing the responsibility of the other members of the company as copartners. In this way, enterprises conducive to the general prosperity are promoted, which individuals would not otherwise engage in.

Formerly, when the pursuits of commerce were less systematically conducted, and its risks and its profits more uncertain, commercial joint-stock companies were much more frequent than at present. These companies were favoured by governments, in the first place, as promoting trade; in the second, as the means of raising a revenue. The government granted to a certain company, or to certain persons, the exclusive right to carry on a certain branch of trade or production, for a certain time, or within certain limits. The company paid the government for this privilege, intending, of course, to indemnify themselves by their profits. They paid a tax with the intention of reimbursing themselves, just as an importer pays duties on his goods, intending to charge the amount, with a profit, in the price to the consumer. It was in opposition to these monopolies that the doctrines of free trade, as they are called, originated; and, considered in reference to such monopolies, those doctrines are undoubtedly just, and so universally held to be; but they are extended by many much beyond these limits. Where only the fund is liable, and not the individuals who contribute it, no injustice is done to the creditors of the company, provided the law secures the actual payment of the fund; for if a person gives credit to a certain fund, knowing the risks to which it is exposed by the kind of business in which it is embarked, he has no ground of dissatisfaction with the members of the company, or the laws, though this fund should prove to be insolvent. This is the most limited responsibility of the contributors to a joint-stock. In other associations of this kind, the contributors are liable to a certain amount for the debts of the concern; as, for instance, to an additional amount equal to that of their respective shares of stock; or each is liable for his proportion of the debts, according to that of his stock. There are also, in the different associations of this description, under the laws of different countries, various conditions on which the liability depends; and also various conditions, which must be complied with, in managing the concerns of the company, in order to keep within the limit of the modified responsibility. Still another description of joint-stock companies is that of limited copartnerships, or companies in which one or more of the members are liable *in solido*, and the others no otherwise liable than for the loss of the proportion of capital which they have put into the concern. This is uniting in the same company the characteristics of a corporation with the most limited responsibility of individual members, and those of a copartnership with an unlimited individual liability. The evident advantages of limited copartnerships, by giving encouragement to persons depending on income, and not devoting themselves personally to the prosecution of active business, to devote their capital to production and trade, without subjecting them to unlimited responsibility, recommend them to adoption in every code of laws. The French code contains such a provision, but none such has heretofore been adopted in the English laws, nor are such associations provided for generally in the United States, though a law to this effect has been passed in New York. Joint-stock companies, whatever may be their form, and however extensive or limited may be the liability of the members, are subject to one abuse, which grows out of their very nature and constitution, and cannot, therefore, be wholly prevented. They are liable to be used, by fraudulent or over sanguine people, as bubbles. The fact of their being subject to such perversion, produces a strong and unjust prejudice against them in the minds of many persons. There is no institution or form of association that is free from abuses and perversions. The engines of greatest power act the most destructively when their powers are wrongly directed, or when they are deranged in their action; but this is no ground of argument against making use of them. It is only a reason for precautions and regulations.

JOINT TENANTS are those that hold lands or tenements by one title, without partition. The creation of an estate in joint tenancy depends on the wording of the deed or devise by which the tenant claims title, and cannot arise by act of law. If any estate be given to a plurality of persons, without adding any restrictive, exclusive, or explanatory words, this makes them immediately joint tenants in fee of the lands. If there be two joint tenants, and one release the other, this passes a fee without the word heirs. Joint tenants may make partition. The one party may compel the other to make partition, which must be by deed; that is to say, all the parties must, by deed, actually convey and assure to each other the several estates which they are to take and enjoy severally and separately. Joint tenants must jointly implead and be jointly impleaded with others. If one joint tenant refuse to join in an action, he may be summoned and severed; but if the person severed die, the writ abates in real actions, but not in personal and mixed actions.

JOISTS. The timber beams used to support floors are called *joists*, or sometimes *floor-joists*, to distinguish them from those used for ceilings, which are called *ceiling-joists*. Ceilings are, however, very frequently formed upon the under sides of the floor-joists, when, of course, separate ceiling-joists become unnecessary. When the span to be floored over does not require joists of greater length than from ten to fifteen feet, the joists are simply pieces of timber laid from one wall or support to another; and such joists are always thinner than they are high or deep. Of course it is quite necessary that all their upper sides should be perfectly flat and level, that they may afford an even bearing for boards to be put upon them; and as the width of scantlings is seldom attended to by sawyers with such precision as to render them fit for this purpose, the necessary equality of depth and consequent even surface is produced by cutting away parts of their under surfaces, where they take their bearings upon the bond timbers, templates or breast-summer, prepared to receive them; for floor-joists ought not to rest on brick-work, but on a plate of timber worked into the bricks to receive them. When the size of openings is larger, the middle of the line of joists will require support, and this is obtained by one or more *girders* or whole timbers passing from one side of the building to the other. Girders are differently disposed according to the nature of the building to be produced; but they should always be die square, and their ends should rest on templates of wood, or cast iron worked into the side walls. In rooms that are longer in one direction than in another, the girders should always extend between the two nearest walls, and they ought not to be scarfed, but should, if possible, be formed of single pieces of timber. In mills, store-houses, manufactories, and such buildings, where strength rather than beauty is required, the joists are usually merely laid across the top of the girder, at right angles to its direction, with no other preparation than merely notching their under edges down upon the top of the girder to such an extent as will produce an even surface for the boarding when placed on their tops. Or sometimes the tops of the girders and bottoms of the joists are notched or halved into each other, which prevents both from shifting out of their places. This construction, however, interferes materially with the headway in rooms, and causes the building to be higher than it otherwise need be, particularly if ceilings have to be made under the floors.—*Millington.*

JONESIA. A small genus of East Indian ornamental plants, of the leguminous order. The Asoca or pinnated species, *J. Asoca*, or *J. pinnata*, is a small evergreen tree, of naturally about 25 feet in height; and was introduced about half a century ago to the hothouses of Britain. Its outline and foliage are handsome; and its flowers are magnificent, and exhibit a brilliant diversity of orange-scarlet, pale-yellow, and bright orange tints. This plant is held in the highest veneration by the Hindoos; and it also occurs in great abundance in Ceylon. It is propagated from cuttings; and it loves a soil of peaty loam.—A climbing species, with prevailingly orange-coloured flowers, *J. scandens*, was introduced to Britain about 27 years ago.

JONQUIL. Several species of hardy, bulbous-rooted, yellow-flowered, ornamental plants, of the daffodil group of amaryllideæ. They are so well-known as not to require description; yet may be popularly characterised as smaller and of more delicate appearance than any of the varieties of the daffodil, and as having a sort of rush-shaped leaves. The large jonquil, *Narcissus jonquilla*, is a native of Spain, and was introduced to Britain toward the close of the 16th century; and has long been one of the most generally diffused bulbous-rooted plants of the flower border. Two varieties of it are in cultivation,—the normal plant, about 9 or 10 inches high, and the double-flowered large jonquil, about 12 or 14 inches high,—both flowering in April and May, and usually coming into bloom a little earlier than the small jonquil.—The three-lobed and the sweet-scented species, *Narcissus trilobus* and *Narcissus odorus*, were introduced in the same year, 1629, from the south of Europe, and have both an average height of from 10 to 14 inches; and they are frequently confounded with each other, and have been regarded by some botanists as two varieties of one species, under the name of *Narcissus calathinus*. The sweet-scented is deservedly a general favourite.—The small jonquil, *Narcissus pusillus*, was introduced to Britain only about 30 years ago, and has usually a height of about 6 inches; and a double variety of it, *N. p. plenus*, is known as Queen Anne's jonquil.—The similar jonquil, *Narcissus similis*, is about the same height as the small jonquil.—Haworth, in his monograph of the narcissi proposes to constitute Jonquilla a separate genus, and to assign to it four species under the names of major, media, minor, and parvicorona; yet he assigns some of the true jonquils to another proposed genus, which he calls Philogyne.

JOSSINIA. A genus of ornamental, tropical plants, of the myrtle family. The orbicular-leaved species, *J. orbiculata*, a white-flowered, evergreen shrub, of 6 or 8 feet in height, was introduced to Britain about 24 years ago; and a number of other species are known.

JOVE'S-BEARD,—botanically *Hydnum Barba-Jovis.* A curious whitish fungus, without any stem, and about a foot in width, growing during summer in the hollow of trees.

JOVE'S-FRUIT,—botanically *Laurus Diospyrus.* A hardy, ornamental, North American, deciduous shrub, of the laurel genus. It was introduced to Britain about 35 years ago; and it attains a height of 6 or 8 feet; and is propagated by layering.

JUDAS-TREE,—botanically *Cercis.* A genus of small, hardy, deciduous, ornamental trees, of the cæsalpinia division of the leguminous order.

The common Judas-tree, *Cercis Siliquastrum*, is a native of the South of Europe, and was introduced to Britain toward the close of the 16th century. It attains a height, in some places, of 20 or 25 feet, and in others, of not more than 10 or 12 feet; but, in all, it branches regularly from the very bottom, and forms a fine object for either lawn, wall, or trellis. Its stem is clothed with a dark greyish bark; its branches are few, irregular, and purplish; its leaves grow alternately and in long footstalks, and are heart-shaped, roundish, and smooth, pleasantly verdant above, and whitish or hoary below; its flowers come out in clusters, on short footstalks, from the side of the branches, and have a fine red or reddish-purple colour, and bloom in May and June; and its pods are long and flat, but do not ripen their seeds, or even develop themselves, in all situations in England. The flowers are eaten by some persons in salads. Four varieties of this plant occur in pleasure-grounds,—the white-flowered, the flesh-coloured, the small-flowered, and the broad-podded. But, as all, in common with the normal plant, are chary of propagation by layering, and can be freely and confidently propagated only from seeds, the varieties are rather accidental than permanent. The seeds ought to be sown in February or March, in any well-prepared but unmanured garden mould. The seedling plants may be removed, in either the first or the second spring, from the seed-bed to the nursery; and there placed at distances of one foot in line and two feet between rows, and occasionally pruned in winter till finally transplanted. The timber of the full grown tree takes a fine polish, and is beautifully veined with black and green, and in consequence is much valued for ornamental work.

The Red bud or Canadian Judas-tree, *Cercis canadensis*, grows wild in Canada, Virginia, and other parts of North America, and was introduced to Britain in 1730. It is commonly smaller than the preceding species, yet equals it in some situations. Its branches are irregular; its leaves are alternate, cordate, and downy; and its flowers have a pale red colour, and begin to bloom in spring before the foliage is full-grown. The ornamental character of this plant, the uses of its flowers and timber, and the method of propagating it, are strictly similar to those of the common Judas-tree. Two varieties of it, with respectively purple and deep red flowers, are in cultivation.

JUGLANS. See Walnut.

JUJUBE,—botanically *Zizyphus*. A genus of fruiting and ornamental shrubs and small trees, of the buckthorn family.

The tree jujube, *Zizyphus Jujuba*, called by Linnæus *Rhamnus Jujuba*, is a large evergreen fruit-shrub of India, and was introduced about 90 years ago to the hothouses of Britain. Its stem is ramose, and naturally about 16 or 18 feet high; its branches are numerous and slender, and have a yellowish bark, and are armed at each joint with a single recurved thorn; its leaves are heart-shaped, roundish, and about two inches in diameter, and are clothed with a yellowish down on their under surface; its flowers come out in clusters from the wings of the branches, and are small and yellowish, and bloom in April and May; and its fruit are reddish, roundish, and about the size of olives, and have a pleasant taste, and are much used by the inhabitants of India. A decoction of the root of this plant, together with several kinds of warm seeds, is prescribed by the Hindoo physicians as a drink in cases of fever and of bowel complaints.

The common jujube, *Zizyphus vulgaris*, called by Linnæus *Rhamnus Zizyphus*, is a hardy deciduous shrub of the southern parts of Europe, and was introduced upwards of two centuries ago to Britain. Its stem has a height of 6 or 7 feet; its branches are crooked and irregular, and are armed at the joints with pairs of strong, straight thorns; its leaves stand on short footstalks, and are slightly serrated and about two inches long and one inch broad; its flowers grow in twos and threes on the sides of the branches, and are small and yellowish, and bloom in August and September; and its fruit are oval-shaped and about the size of middle-rate plums, and have a viscid touch and a sweetish taste, and were formerly used in medicine as good pectorals in cases of cough and pleurisy, and are now used in Spain and Portugal as a coarse desert and a dry sweetmeat in winter.

Four other species which have been introduced to Britain, all evergreen shrubs, are more or less esteemed in their native country for their fruit, —namely, the lote-tree, *Zizyphus Lotus*, formerly called *Rhamnus Lotus*, 4 or 5 feet in height, from Africa,—the white-fruited jujube, *Zizyphus albens*, 10 or 12 feet high, from China,—the shining jujube, *Zizyphus nitida*, 6 or 8 feet high, from China,—and the Napeca plant, *Zizyphus Napeca*, 15 or 20 feet high, from Ceylon.—Two introduced species, both hardy and shrubby,—*Z. Spina-Christi*, an evergreen from Egypt, and *Z. incurva*, a deciduous shrub from Nepaul,—sometimes share with the paliuri the popular name of Christ's - Thorns. See the article Christ's-Thorn. About a dozen other species have been introduced; and about a score more are known.

JULIBRISSIN. See Acacia.

JULY. See Calendar.

JULY-FLOWER. An evergreen, useful, tropical tree, of the mimosa division of the leguminous order,—variously called *Prosopis juliflora*, *Mimosa piliflora*, and *Acacia falcata*,—introduced to British hothouses about 46 years ago from the West Indies, and attaining in its native country a height of about 35 feet. But the name July-flower, though more frequently in the corrupted form of gilliflower, is popularly applied to some of the dianthi, and to all the annual and biennial stocks.

JUNCAGINEÆ. A small order of endogenous plants, comprising the two genera triglochin and scheuchzeria, and consisting wholly of small and utterly unimportant bog weeds, with grassy leaves, and greenish-yellow flowers in spikes or racemes.

JUNCUS. See Rush.

JUNE. See Calendar.

JUNGERMANNIA. See Hepaticæ.

JUNIPER. A genus of coniferous, evergreen trees and shrubs, having imbricated, scale-like leaves, closely allied to the cedar and pine, but differing in having the scales of the cone united, and forming a little berry. One species grows wild in Britain; and nearly 20 species have been introduced from Continental Europe, North America, and other regions. Two of the species are medicinal; four or five are valuable for their timber; and all are more or less ornamental in pleasure-grounds and shrubberies. Three species from China, Barbadoes, and the Bermudas are somewhat tender; but all the other species are quite hardy. One of the two medicinal species, constituting the type of a subgenus, which comprises more than one half of all the species, will be noticed in the article Savine.

The common species, *Juniperus communis*, grows wild on the heaths and chalky hills of Britain, and of many of the northern parts of Continental Europe. It is naturally a low, rigid, exceedingly branching shrub of only 5 or 6 feet in height; and is very often so cropped and kept down by the browsing of sheep as not to have a height of more than 2 or 3 feet; but when planted in good soil, and allowed the full benefit of culture, it readily attains a height of about 15 feet. The stem is smooth and stiff; the leaves are sessile, ternary, entire, channelled, narrow, sharply-pointed, glaucous, and very numerous; the catkins are axillary, sessile, solitary, ovate, and small; and the fruit, though cones, have the appearance and bear the name of berries, and are globular and of a blackish-purple colour, and contain each three angular seeds. These berries have a peculiar aromatic terebinthine odour, and a pungent, sweetish, bitterish taste; and are made use of to impart their peculiar flavour to spirit, constituting *gin*. They are also used by brewers to give pungency to the lighter kinds of beer. In some parts of Europe they are roasted, ground, and used as a substitute for coffee. They are also used in Sweden and in Germany as a conserve, and as a culinary spice, and especially to give flavour to sourcrout. Like all plants of the terebinthinate class, they have a decidedly diuretic property, and they are much used as diuretic medicines. The oil of juniper, if mixed with nut-oil, forms an excellent varnish for pictures, wood-work, and iron, which it preserves from rust. From the bark exudes a resinous gum, known by the name of *gum sandarach*. It is in small, yellow pieces, very brittle and inflammable, and of a pungent, aromatic taste. When finely powdered and sifted, it constitutes the substance so well known under the name of *pounce*. It is also used by painters in the preparation of varnish, especially of the kind termed *vernix*.—Four permanent and well-defined varieties of the common juniper are in cultivation,—the fruticose, *J. c. fruticosa*, a native of Britain, and naturally about the same height as the normal plant; the Swedish juniper, *J. c. suecica*, introduced from the north of Europe, and naturally twice or thrice the height of the normal plant; the oblong-fruited juniper, *J. c. oblonga*, about 5 or 6 feet high, and introduced from France; and the dwarf juniper, only 2 or 3 feet high, and introduced from Siberia.

The Virginian juniper, or red cedar, *Juniperus Virginiana*, is frequent throughout the United States, from near lat. 45° to the point of Florida, and westward as far as the Rocky mountains. It does not attain large dimensions, ordinarily not exceeding 30 feet in height, but is highly esteemed for the durability and lightness of the wood, which is employed in the upper part of the frames of vessels, for posts, &c., and is also an article of export to England. So little regard has been paid to the preservation of this tree, and such has been the demand for the timber, that it is now not easily obtained, and is becoming scarcer every day. The farther south and the more barren the soil in which it grows, the better is the quality of the wood. The red cedar, in many places, appears as the pioneer of the American forest, fixing upon dry and exposed situations, and fostering beneath its shade young trees of various species, till it is finally overtopped by them, and in its turn disappears. This species was introduced to Britain a little after the middle of the 17th century. Two small or shrubby varieties of it, the humble and the Carolinian, and many small seedling subvarieties, are cultivated for ornament.

The Spanish juniper, or sharp cedar, *Juniperus oxycedrus*, was introduced to Britain upwards of a century ago from Spain. It readily rises on good soils to the height of 15 or 16 feet; and, if not crowded with other trees, and left untouched from the first planting, it will feather from the bottom to the top, and become a very beautiful object. Its leaves are awl-shaped, very short and sharp-pointed, and spread finely open, and give the plant a handsome appearance; its catkins appear in May and June; and its cones or berries are large and reddish, and very elegant.

The incense-bearing juniper, sometimes sharing with the preceding species the name of Spanish cedar, *Juniperus thurifera*, was introduced to Britain from the south of Europe about the middle of last century. It equals the Virginian juniper in height, and is considerably taller than the tallest of the other junipers. It is a beautiful, regular-growing tree; and rises in a conical form; and, if allowed good treatment, will readily soar up, on a pleasure-ground, to the height of more than 30 feet. Its leaves are imbricated, and lie over one another four ways, and are acute and of a fine green colour; and its berries are very large and of a fine black colour, and adorn the young branches in great plenty, and combine with the foliage to produce a deeply pleasing effect.

The Bermudean cedar, *Juniperus Bermudiana*, was introduced to Britain in the latter part of the 17th century. It figures in this country only as a half-tender and somewhat rare shrub; but, in the Bermudas and in Continental America, it is a considerable timber tree, and has been in requisition, not only for wainscotting and cabinet-work, but even for ship-building. The wood of it has a peculiarly aromatic smell; and is imported from the Bermudas; and, among other uses, is employed in the manufacture of black-lead pencils.

JUPITER'S BEARD. See KIDNEY VETCH.

JURY. The right of punishing is inseparable from the executive power in a state; but, since the penal authority has to decide respecting the property, freedom and life of citizens, the executive or highest power may easily degenerate into despotism, and the relation of the citizen to the government, into slavery, if it can punish at will. It consequently becomes an object to deprive the government of the will and power to punish unjustly. Now, since, in every case of punishment, a double question is to be answered—first, whether the accused committed the act with which he is charged,—and, secondly, if he is guilty, what consequences do the laws attach to the deed, and what punishment must be inflicted—the executive power will be sufficiently restricted, if we leave it to answer merely the last question, and leave the decision of the first to a separate, independent authority. This can neither be limited to single individuals, nor to a permanent college. Both are too much subject to the influences of the supreme power. The mass of the people, alone, is not to be corrupted. But, since the mass of the people cannot sit in judgment, and it is also known how little impartial justice is to be expected from the multitude, when their own interest is concerned, this agency must be committed to sworn substitutes, chosen for single cases, or only for short periods, in order that the popular tribunal may not degenerate into an established office. These substitutes, as they are not determined beforehand, cannot become the object of corrupting influences, which, though they may find access with some, hardly can with all. In these views lie the foundation and essence of juries; namely, of the petty jury in England, and of the *jury de jugement*, in imitation of it, among the French.

The Origin of the Trial by Jury.—It has been traced back by antiquarians to a very early period in English history, and seems, indeed, in some form, if not coëval with the origin of the civil government in England, at least to have been used time out of mind in that kingdom. It is lost among the early Saxon colonies; and probably was derived from the mode of administering justice by the peers of the litigant parties in the feudal institutions of Italy, France, and Germany. Mr. Justice Blackstone considers that this tribunal was universally established among all the northern nations, and so interwoven with their very constitution, that the earliest accounts of the one give us also some traces of the other. Mr. Wynne seems to entertain a different opinion, and, after stating that its origin is obscure, he asserts, that it is the noblest form of policy that was ever invented on earth, and comes nearest the impartiality of heaven. But, whatever may be the origin of the trial, it is of very high antiquity. And Magna Charta referred to it as an existing institution, and provided that no person should be hurt, either in his person or property, unless by the judgment of his peers or the laws of the realm (*nisi per legale judicium parium suorum vel per legem terræ*).

The different Kinds of Juries.—Juries are of two sorts, viz. grand juries and petty juries. The former may consist of any number more than twelve, and less than twenty-four persons. The office of the grand jury is to accuse persons who are supposed to be guilty of an offence. It may, therefore, properly be called the *jury of accusation.* The petty or petit jury consists of twelve persons only, and may properly be called the *jury of trials*, both in civil and criminal cases.

The Grand Jury.—We shall first consider the organization, functions, and proceedings of the grand jury. The mode of accusation is by a written statement in solemn form, describing the offence, with all the proper accompaniments of time and circumstances, and certainty of act and person, which is called an *indictment*, or by a mode less formal (which is usually the spontaneous act of the grand jury), called a *presentment*, and which is afterwards put into solemn form by some proper officer. No indictment or presentment can be made except by the concurrence of at least twelve of the jurors. The grand jury may accuse upon their own knowledge; but it is generally done upon the testimony of witnesses under oath, and other evidence produced and heard before them. The proceedings of the grand jury are, in the first instance, at the instigation of the government or other prosecutor, and are *ex parte*, and in secret deliberation. The accused has no knowledge of, nor right to interfere with, their proceedings. If they find the accusation true (which is usually drawn up in form by the public prosecutor), they write upon the indictment the words "a true bill," which is signed by the foreman, or chief of the grand jury, and is presented to the court publicly, and in the presence of all the jurors. If the indictment is not proved to the satisfaction of the grand jury, the word "*ignoramus*" (we are ignorant), or "not a true bill," or "not found," is written on it by the grand jury, or by their foreman, and it is then, in common parlance, said to be *ignored*, and the accusation is dismissed, as unfounded. When the grand jury return an indictment as a true bill (*billa vera*), the indictment is said to be *found*, and the party stands indicted, and may be required to be put upon his trial. When the indictment is not found, or is declared to be not true, the accused, if he is in custody, or has been in any way required to appear at the court, and answer to any accusation against him, is entitled to be discharged, or dismissed from any further inquiry or attendance before the court. Every public offence may be properly the subject of an indictment, and taken cognizance of by the grand jury of the county within which it is committed. But there is another mode of proceeding at the common law, at the suit of the king, called an *information*, which is similar to an indictment, except that it is not found by the grand jury, and is filed, *ex officio*, by the proper officer of the government. An information cannot be filed except in cases of mere misdemeanors, or offences not capital; for, whenever any capital offence is charged against a party, he cannot be put upon his trial unless the accusation be made by the grand jury by indictment.

The functions being such as we have stated, it is obvious that the duties require great care in the selection of the persons who are to serve as grand jurors. A precept, commonly called a *venire facias*, issues to the sheriff of every county, some time before any court of criminal jurisdiction is held therein, requiring him to summon twenty-four good and lawful men of his county to attend the court, to inquire into, and present all offences committed within the body of the county. At the common law, these grand jurors are required to be freeholders of the county, and in England, where the sheriff makes the selection, they are usually gentlemen of the first respectability in the county. In the United States, different modes prevail in different states in the selection of grand jurors. In some, the grand jurors are chosen, as in England, by the sheriffs; in others, as in the New England States, the grand jurors are drawn by the town officers, from boxes containing the names of all the persons qualified to serve, from time to time, and in such numbers as are required; and the names so drawn are returned to the sheriff, and by him to the court. But, in whatever way the grand jurors are selected, their names are returned on a piece of parchment or paper, by the sheriff, which is called a *panel*, and as many of them as appear in court are sworn on the grand jury, not exceeding twenty-three, so that twelve may constitute a majority. Their oath is, in substance, that they will diligently inquire and true presentment make of all offences committed within the county; that the government's counsel, that of their fellows, and their own, they will keep secret; that they will present no man for envy or malice; neither will they leave any one unpresented from fear, favour, affection, or hope of reward; but that they will present things truly as they come to their knowledge, according to their best understanding. Usually, the presiding judge of the court instructs them in the matters which are within their jurisdiction, by delivering to them a charge, containing a summary of the offences and other business which may come before them. They then retire to their room, and sit, as has been said, in secret, hearing evidence in favour of the prosecution only, as the main question before them is, whether the party accused ought to be put upon his trial to answer the accusation. But they are always bound to act upon legal evidence, and are instructed that they ought not to find an indictment unless upon their oaths they are persuaded, so far as the evidence goes, that the accusation is true. It has been already stated, that the grand jury is to inquire only into crimes committed in the county for which they sit. And this is regularly true at the common law, for no man was bound to answer for any crime but before his peers in the county and neighbourhood where it was committed. But, by sundry statutes, both in England and America, some offences, not committed within a county, have, to prevent a defect of justice, been made cognizable therein. To enumerate these offences would occupy too large a space; and probably no two states in the Union have enacted precisely the same provisions. There are proper powers vested in the courts to compel the attendance of grand jurors; and if any are returned who are not qualified, they may be excluded from the panel; and if an indictment be found by persons not qualified, the accused may except to it on this account. Thus careful has the law been, in the original selection of grand jurors, who are supposed, and indeed required, to be men of integrity, impartiality, and intelligence, and above all just objection. And thus a body of men, brought together for the occasion, and for that only, are placed between the government and the citizen, as a shield against oppression and injury, and to afford a reasonable protection to him, if he be not justly suspected of a crime.

Petty or Petit Juries.—These consist, as has been already said, of 12 persons, and no more, for the trial of all criminal offences, and of all issues of fact in civil cases at the common law. There are some peculiar modes of trial by jury in England, where a larger number than 12 is required, which may be called the *extraordinary* trial by jury; as, for instance, a grand assize for the trial of issues in writs of right, which consists of 4 knights and 12 other persons; and the jury of attaint, to convict a former jury of a corrupt verdict, which consists of 24 jurors. But these modes of trial are, at present, wholly disused in America; and, in England, that of a jury of attaint has fallen into neglect, since the general use of the remedy of moving for a new trial, where the verdict is unsatisfactory. And first, as to the trial by jury in civil cases. This is generally confined to issues of fact in proceedings at common law, as contradistinguished from proceedings in equity and admiralty. When, then, the parties have, in their written pleadings, or allegations, come to a fact which is denied on one side, and affirmed on the other, in a regular mode, the cause is said to be *at issue*, and the fact in controversy is to be ascertained by a jury. For this purpose, in England, a precept issues to the sheriff of the proper county, requiring him to select and summon to the court at which the trial is to be had, a suitable number of jurors, for the trial of the cause; and he accordingly makes return of the names of the jurors, on a piece of parchment or paper (thence, as before stated, called a *panel*), who are compellable to attend at the time and place appointed. If the sheriff have any interest in the case, or is not impartial, or is related to the parties, the jurors are selected by some other proper officer, and usually by the coroner of the county. The qualifications of petty jurors do not differ, generally, from those required as to grand jurors, their duties being equally important, and requiring equal intelligence. When the cause is called for trial, if all the jurors do not appear, or any of them are justly objected to and set aside (of which we shall speak hereafter), the deficiency may be supplied from among the by-standers, having suitable qualifications, which is called taking jurors *de talibus circumstantibus*, from which circumstance the persons thus selected are denominated *talesmen*. The jury, being thus full, and above objection, are sworn (severally or together, according to the local usage in each state) well and truly to try the issue between the parties, and a true verdict to give "according to the evidence" (or "according to the law and the evidence given them," by the local usage of some states). In some cases, special juries are allowed to be selected, in a particular mode, for the purpose of trying particular causes; in other cases, the trials are by a jury chosen in the ordinary manner, and thence called a *common* jury. After the jury is sworn, the cause is then tried in open court, the evidence is offered, and the witnesses publicly sworn and examined in the presence of the judges, the counsel on each side, the jury, and all other persons in attendance. The question, whether any evidence is competent to be given to the jury, is, if any objection is made, first decided by the court. If rejected, it is never heard by the jury; if admitted, it is then read, or, if given by a witness, he is then examined before the jury. The party who calls a witness first examines him, and he is then liable to be cross-examined by the other side; and if any question is asked, which either party deems improper, the opinion of the court is taken on it before the witness is allowed to give his answer. So, also, it is, in respect to any written evidence or document offered at the trial. And if either party requests it, the judge who presides at the trial makes a note, in writing, of the objection, so that the party may avail himself of it afterwards, upon a motion for a new trial, or by a writ of error, in a suitable manner. Before the evidence is offered, the counsel for the party who opens the cause, on each side, makes a short introduction, stating the case, the points in controversy, and the facts which he expects to prove, so that the jury may more clearly understand the bearing of the evidence, as it is produced. After all the evidence is gone through, the counsel on each side argue the case to the jury, at large, commenting upon every part of it, and each insisting upon a verdict in his favour. If any questions of law arise (as in most instances they do), the judge is requested, and is bound, publicly to state his opinion on all the points of law applicable to it. This he ordinarily does in summing up the case, after the arguments of the counsel are over; but he may do it before, if he chooses. When the arguments are finished, the presiding judge proceeds to address the jury, stating to them the questions, recapitulating the evidence, and commenting on it in such a manner as he deems correct, for the purpose of enabling the jury to understand it well, and to apply the law properly to it. In these addresses, he often freely expresses his opinion as to the weight of evidence, the sufficiency of the proofs, the force of particular objections, and the comments of the counsel. But, it being a principle of law, that the jury is to respond as to matters of fact, and the judges as to matters of law, it is always understood, that these comments on matters of fact are not binding on the jury, and that they are given solely with a view of enabling the jury to exercise their functions more perfectly, and that the jury are at liberty to disregard them if they please. But, generally speaking, they do receive great weight from the jury, who naturally place confidence in the judges, from their talents, experience and impartiality, and therefore, unless the judge obviously exhibits some improprieties, or betrays some unjustifiable feeling, they consider him as a friend, aiding and assisting them in their duty; and, his addresses being always in public, and open to the criticism of the public, as well as of the profession, it rarely occurs that his conduct is deemed exceptionable. Still the jury have a right to form, and do form, an independent judgment upon matters of fact; and their judgment is often conclusive.

After the judge has finished his summary, the jury withdraw into a private room, where they are kept together for the purpose of deliberation, until they have all agreed in a verdict (*veredictum*) upon the point in controversy. They are not permitted to have any intercourse with any other persons, and are allowed, during their continuance in secret session, to have only such food and other necessaries as are indispensable. Indeed, by the old law, they were to be kept without meat, drink, fire or candle, until they were agreed, unless by permission of the court, which soon, however, became almost a matter of course. When they are agreed, they come into open court, and, their names being called, they deliver in their verdict, which is recorded by the proper officer, who then reads it aloud to the jury, and asks them if they agree to it as recorded, to which they all publicly assent. If either party doubts it, the jurymen are severally asked if they agree, which is called *polling* the jury. Sometimes, when the facts are very complicated, or involve questions of law of great difficulty, the jury, instead of finding a general verdict, that the issue of fact is for the plaintiff or for the defendant, state all the facts at large, and ask the court to decide upon those facts, whether the issue ought to be found for the plaintiff or for the defendant. This is called a *special* verdict. It rarely occurs in criminal cases, and is not very common in civil cases. But the jury are never obliged to find a special verdict, and may, in all cases, give a general verdict, if they choose. If the jury, after being kept together a considerable time, cannot agree, they are usually brought into court by the proper officer, and the court, if their difficulty is about any matter of law, often makes additional explanations. But if, after every reasonable effort, the jury continue to disagree, they are discharged by the court, and the cause must then be tried anew. In criminal cases, and especially in capital cases, the court with great reluctance allow the discharge of a jury, after the cause is once committed to them.

Next, as to the trial by jury in *criminal cases*. Here the qualifications of jurors do not differ from those required in civil cases. But the law, with a view to prevent the undue influence of the government in the selection of jurors, and the undue prejudices arising from public opinion, has thrown additional guards round the party accused. He is not only entitled to be tried by good and lawful men, of the neighbourhood where the crime is alleged to have been committed, but to be confronted with the witnesses, and to have, in capital cases, some privileges, which are not allowed either in civil cases or in offences of a subordinate character. And, in the first place, the right of challenge, which, though it exists for many purposes in civil trials, is of far more consequence and extent in criminal trials.

A challenge is, properly speaking, an objection or exception to a juror, or to the whole jury, as incompetent to sit in a trial. It is of two sorts: the first is a challenge to the array, or an exception to the whole panel or list of jurors, as they are arrayed or set in order by the sheriff in his return. And it may be taken on account of the partiality of the sheriff, when he selects the jury, or of some default, omission or illegality of himself or of some other officer or functionary concerned in arraying or returning the panel. These exceptions are, or may be, various in their nature and extent, in different states; and the particular exceptions, at the common law alone, would not, independently of those provided for or disallowed by statute, be very instructive. This challenge may be either for a principal cause or to the favour, the former of which is founded upon positive proof or presumption of impropriety; the latter is founded upon less strong presumption or suspicion, and therefore properly to be inquired into, or to be decided by the sound discretion of the triers. Secondly, the other sort of challenge (which also may be for a principal cause or to the favour) is a challenge to the polls, that is, an exception to particular jurors, answering in some degree to the *recusatio judicis* of the civil and canon law. Challenges to the polls, at common law, have been reduced to four sorts: 1. Challenge *propter honoris respectum*, or in respect to nobility; as, if a lord or peer of the realm in England be empanneled on a jury, he may be challenged by either party, or may challenge himself. 2. Challenge *propter defectum*, or for want of proper qualifications; as if a person be an alien or a slave; or in cases where he is required to be a freeholder, if he is not such; or is not of a suitable age, as a minor; or is a female, for females are not allowed to be jurors; or is convict of an infamous crime, or is otherwise disqualified. 3. Challenge *propter affectum*, for suspicion of bias or partiality. This may be a principal challenge, or to the favour. It is a principal challenge, as has been already stated, when there is pregnant proof or presumption of partiality or of malice, as that a juror is of kindred to either party (at the common law, in the ninth degree); that he has already prejudged the cause, as an arbitrator; that he has an interest in the cause; that he has taken money for his verdict; that he has formerly, as a juror, tried the same cause; that he is the servant, master, attorney or counsel of one of the parties. A challenge to the polls for favour (which supposes a doubt of impartiality) is where the party has no principal cause of challenge, but has suspicion of favour, and offers circumstances in support of such suspicion. In such a case, the validity of the objection is, by the common law, left to the determination of *triers*, whose office it is to decide whether the juror who is objected to is favourable or unfavourable, or, rather, whether he stand indifferent between the parties. The triers, in case the first man called as a juror is challenged, are two indifferent persons, named by the court; and if they try one man, and find him indifferent, he is sworn, and then he and the two first triers try the next who is objected to; and when a second is found indifferent, those two who are sworn as jurors become the triers of all the others who are objected to, in lieu of the two triers first chosen. 4. Challenge *propter delictum*, or on account of some crime, of which the person called as a juror has been guilty, and which imports a disability and discredit as a juror. This applies to cases of a capital nature, and other infamous crimes, such as treason, felony, perjury, conspiracy, and other species of the *crimen falsi*. A person called as a juror may be called to say the truth (whence he is said to be interrogated *voir dire, veritatem dicere*) in respect to such causes of challenge as are not to his discredit or dishonour; but he cannot be called upon to acknowledge himself guilty of any crime, or other thing which renders him infamous.

These are all the causes, strictly speaking, of challenge by the parties. But many persons are entitled to be excused from serving on juries, and, on this account, may plead the excuse for themselves, though the parties may not take the exception. Among these are magistrates, aged persons, and persons holding particular offices, and others having special exemptions. The challenges above mentioned equally apply to civil and criminal cases. But in favour of life, in capital trials, the accused is indulged the privilege of challenging a certain number of persons, called as jurors, without assigning any cause; and this privilege is thence called the right of *peremptory* challenge. This is a provision founded in great humanity and tenderness towards persons capitally accused. The reasons commonly assigned for it are, 1. that every person is liable to strong dislikes and prejudices, in respect to particular persons, merely from their appearance, manners and gestures, although they are strangers to him, and that even a caprice or feeling of this kind may, in the course of the trial, embarrass the party in his defence; 2. that upon a challenge for cause shown, the reason may prove insufficient, and, if the party had no right of peremptory challenge, he might be tried by a juror who, from the very circumstance of being objected to, might conceive a prejudice against the accused. On these accounts, he is at liberty to challenge the juror peremptorily, after he has, for an insufficient reason, challenged him for cause; and, as the object of all trials is to allow a fair and full defence, the accused ought, at least, to have his wishes consulted so far as to exclude those whom he distrusts in the first instance. But as it is obvious that the right of peremptory challenge, if not limited by some known boundary, might for ever prevent a trial, the law has fixed a definite number, to which the party is confined. The common law fixed this number at 35, or one short of three full juries; and that still remains the rule in all trials for treason. But in other capital offences, the right is now generally restrained, by statute, to 20, both in England and America. If a person attempts to challenge beyond this number, his challenge is disregarded. If, by reason of peremptory or other challenges, a sufficient number of jurors are not found, talesmen are appointed, as in civil cases. If several persons are tried at the same time, upon one indictment, each one is entitled to his full number of challenges, and one may challenge a juror not objected to by the others, and he must be excluded altogether; for every juryman must be above any objection by any of the persons tried.

We have thus far treated of challenges by the party accused. The government has, strictly, no right to challenge, except for cause shown; but for cause shown the government may either challenge the array, or the polls. in the same manner as a private person. However, it is usual, at least in England, if a juror is objected to by the government, not to call upon the government to show cause until the panel is gone through, and then, if sufficient jurors are not found and sworn, the cause of the challenge may be inquired into; for, if there is a full jury without the persons objected to by the government, there is no strong reason to insist upon their being sworn, although no good cause has been shown.

There are some other provisions favourable to prisoners accused of capital offences, and especially of political offences, which deserve notice. In England, in cases of treason, the prisoner is entitled to a copy of the indictment five days before his arraignment for trial, and a copy of the panel of jurors who are summoned, and their professions and places of abode, ten days before his trial, and a list of the names of the witnesses to be produced against him, the like length of time before the trial. He is also entitled, at the expense of the government, to have witnesses summoned in his behalf, to establish his defence, and to have counsel assigned to assist him in his defence.

JUSSIEUA. A genus of tender, ornamental, herbaceous, yellow-flowered, aquatic plants, of the order onagrariæ. Upwards of a dozen species have been introduced to Britain; and about a score more are known. Most of the introduced species are either annuals or biennials, and less than 3 feet high, and require stove heat, and bloom in the early part of autumn. But the large-flowered, *J. grandiflora*, is a greenhouse perennial from Carolina; and the rough, *J. scabra*, is a perennial of 4 or 5 feet in height from South America. The stem of one of the longest and best known is single, upright, red, hairy, channelled, and about 3 feet high; its leaves are alternate and spear-shaped; its flowers come out from the wings of the leaves toward the top of the stem, and have each five petals, and sit close to the stem; and its seed-vessels are oblong, and about an inch in length, and shaped very like cloves.

JUSTICE OF THE PEACE. The word *justice* is applied to judicial magistrates; as *justices* of such a court, and, in the English laws, *justices of the forest*, *hundred*, *of the labourers*, &c.; and hence the appellation *justice of the peace*—that is, a judicial magistrate intrusted with the conservation of the peace. A great part of the civil officers are, in fact, the conservators of the peace, as their duty is to prevent or punish breaches of the peace. Thus the judges, grand-jurymen, justices of the peace, mayors and aldermen of municipal corporations, sheriffs, coroners, constables, watchmen, and all officers of the police, are instituted for the purpose of preventing, in different ways, crimes and disturbances of the peace of the community, or for arresting, trying and punishing the violators of the laws and good order of society. The justice of the peace, though not high in rank, is an officer of great importance, as the first judicial proceedings are had before him in regard to arresting persons accused of grave offences; and his jurisdiction extends to trial and adjudication for small offences. In case of the commission of a crime or a breach of the peace, a complaint is made to one of these magistrates. If he is satisfied with the evidence of a commission of some offence, the cognizance of which belongs to him, either for the purpose of arresting, or for trying the party accused, he issues a warrant directed to a constable, or other executive officer designated by the law for this purpose, ordering the person complained of to be brought before him, and he thereupon tries the party, if the offence be within his jurisdiction, and acquits him or awards punishment. If the offence charged be of a graver character, the adjudication upon which is not within the justice's jurisdiction, the question then is, whether the party complained of is to be imprisoned, or required to give bonds to await his trial before the tribunal having jurisdiction, or is to be discharged; and on these questions the justice decides according to his view of the law and the facts. In England, there are some officers, as the master-of-the-rolls, some municipal authorities, &c., who are justices of the peace by prescription, in virtue of their other office; but, in general, the appointment is by commission; and, in England, when a new commission issues to justices in a certain county, this supersedes for-ner commissions for the same county, of course. t is evidently of the greatest importance to the eace and good order of a community, that the ustices should be discreet, honest, and intelligent.

JUSTICIA. A large and diversified genus of rnamental plants, constituting a large and conpicuous portion of the acanthus order. They ave opposite and simple leaves, and elastic and lehiscent capsules. The great majority are naives of the tropics; and none are quite hardy in ur climate. About 70 species have been introduced to the gardens of Britain; and about 80 r 90 more are known. Three or four of the ntroduced species are annuals or biennials; a ew are herbaceous evergreens; seven or eight are vergreen ligneous trailers; a large proportion re evergreen undershrubs; and most of the remainder are middle-sized evergreen shrubs. All re more or less ornamental; a few are eminently eautiful or positively magnificent; and a coniderable number are medicinal.

The adhatoda, one of the longest known, *J. Adhatoda*, is a tall evergreen shrub of Ceylon, and was brought to Britain about the end of the 17th entury. English gardeners long called it the eetle-nut, and afterwards the Malabar nut; nd some supposed it to yield the leaves and uts which the Chinese chew in the manner of obacco. It thrives well enough in a greenhouse, et commonly ranks as a plant of the stove. Its tem is strong and woody, and has a height of rom 10 to 14 feet, and sends out many spreading ranches; its leaves are ovate-lanceolate, and bout 6 inches long and 3 inches broad; and its lowers come out in short spikes at the end of the ranches, and have a white colour with some ark spots, and bloom in June and July. The oot and the leaves of this plant have a bitterish taste, and in the form of decoction and electuary are prescribed by the Hindoo physicians as a remedy for spasmodic affections, for some kinds of asthma, and for intermittent fever.

The flesh-coloured justicia, *J. carnea*, is a very beautiful, autumn-blooming, evergreen shrub, of about 4 feet in height, introduced about 20 years ago from Rio Janeiro. The showy justicia, *J. speciosa*, is a magnificent, purple-flowered, autumn-blooming, evergreen shrub, of about the same height as the preceding, introduced 20 years ago from India. The beautiful justicia, *J. venusta*, is a very handsome, purple-flowered, September-blooming, evergreen shrub, of 5 or 6 feet in height, introduced within the last quarter of a century from Bengal. The pectoral justicia, *J. pectoralis*, popularly called the pectoral balsam, is a purple-flowered, May-blooming, evergreen herb, of about 3 feet in height, introduced to Britain about 60 years ago from the West Indies, and much esteemed in its native country as a vulnerary. The expelling justicia, *J. ecbolium*, is a blue-flowered evergreen shrub, of about 3 feet in height, blooming from early spring till early autumn, introduced to Britain nearly 90 years ago from India, and held in high repute among the Hindoos as a diuretic. The large-snouted justicia, *J. nasuta*, is a small, evergreen, white-flowered shrub, about two feet in height, blooming from February till October, introduced upwards of 50 years ago from India; and both its fresh root, and its blunt-pointed leaves, when bruised and mixed with lime juice, are regarded by the Hindoos as a sovereign application for ringworm and other cutaneous eruptions. Three or four other species are regarded as medicinal in India; and the two-flowered species, *J. biflora*, is used in Egypt as a poultice.

END OF VOLUME SECOND.

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